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CARL FRIEDRICH GAUSS AND HIS CHILDREN.

THE life of Carl Friedrich Gauss has been sketched repeatedly, yet, in view of the interest attached to every bit of new information concerning men of genius, we venture to touch upon a few events of his later life and to speak of his descendants.

The 16th of July, 1899, will be the 100th anniversary of Gauss's graduation with the degree of Doctor of Philosophy. The 50th anniversary was a day of celebration at Göttingen. Gauss was still in full possession of his powers and was greatly admired and beloved. His daughter Theresa describes the memorable day in a letter, dated December 5, 1850, and written to her brother Eugene in St. Charles, Mo. In translation the passage is as follows:

"I cannot tell you much of our quiet life; one day and one year is always very much like every other. But they are contented days and years, as father even now in his advanced age still possesses unimpaired health and an always cheerful disposition. A year and a half ago, in July, '49, he celebrated his '50-jähriges Doctorjubiläum'—or rather the University and the city celebrated it for him with general love and sympathy. He himself was very much opposed to having this day noticed, but, without his knowledge, everything had been prepared for it. From near and far the University had invited strangers; father's friends and eminent scholars came, many delegations from other cities, who brought him congratulations, honorary doctor's diplomas and three new orders. From Braunschweig and Göttingen he received honorary citizenship; from the King, con-

gratulations in his own handwriting and a higher order (erhöhten Ordensgrad). There was no end of letters and communications. In the morning festive processions began to congratulate him, all the authorities of the city, of the University, of the school, strangers, acquaintances — probably about fifty persons. Then father himself delivered a lecture in the hall of the University, which was overcrowded with spectators and listeners and had been decorated with garlands and flowers like a fairy hall. Even the houses in the streets were decorated with flowers; in the city there were waves of people in festive attire (wogte es von geputzten Menschen), as on a holiday. When, at last, in the evening at seven, father came home from the great banquet, he was, indeed, quite exhausted, and it was well that the torchlight procession that the students had intended for him was abandoned upon his wish, but the love and sympathy which had been shown him from all sides had, in spite of all fatigue, pleased him indescribably. How sad was it though that, where so many strangers had congregated on his day of honor, not one of his beloved sons could be with him!! Even Joseph had been compelled to decline, as his position as railway director did not, at that time, make his absence from Hannover possible."

Gauss was married twice. By his first wife he had two sons (Joseph and Louis) and one daughter (Minna). Louis died in childhood. By his second wife he had two sons (Eugene and Wilhelm) and one daughter (Theresa). Eugene and Wilhelm settled in the United States. In Germany Gauss has only one grandchild, Carl Gauss, now living at Hameln, in Hannover. He is a son of Joseph. He was only six years old when his grandfather died, in 1855. He still remembers how his celebrated grandfather tried to show him a star through the great telescope; how he stood full of expectation near the ocular, while his grandfather, wearing a velvet cap, was turning the crank which moved the shutter on the dome of the observatory. Another time the child was playing in the garden of the observatory when his grandfather met him and asked: "What do you expect to make of yourself?" whereupon young Carl replied: "Well, what do you expect to make of *yourself?*" Then the old man patted the child's shoulder and said smilingly: "My boy, I am already somebody."

In a letter addressed to the writer, Carl Gauss speaks also of his father, Joseph, who, after completing the gymnasium in Göttingen, went into the German army, but subsequently got leave to assist his father in the triangulation of the Kingdom of Hannover. When the construction of railways was first begun in that part of Germany officers of the army were selected, along with some foreign experts, to superintend the work. So it happened that Joseph Gauss left the army and served as an engineer. In 1836 and '37 he was sent by his government to the United States to study the more advanced methods of railway construction in the New World. Later he became 'Oberbaurath' and director of railroads and telegraphs in Hannover. Finally he was assigned to the superintendence of the special department of telegraphs, which position he kept until the outbreak of the war of 1866. It is of interest to think of him in connection with the telegraph—the instrument in the invention of which his father had played so important a rôle. It is well known that as early as 1833 C. F. Gauss and W. Weber had a telegraphic line between the observatory and the physical cabinet in Göttingen.

Some biographers assert that Gauss's favorite child was Joseph, but there is reason to believe that the father at first built high hopes on what Eugene would do. In a letter to Bessel (November 21, 1811), after writing about hypergeometric and logarithmic series, he says: "Wenn eines meiner Kinder des Vaters Liebe zu den exacten Wissenschaften erben sollte, so ist es wahrscheinlich eher dieser Eugen als sein leichtblütiger Bruder Joseph." As the infant reached boyhood he displayed far more than ordinary ability, especially in languages. His father once took a French

book, examined him in the knowledge of French, and then said that he knew that language well enough and need not study it any further. Another time Gauss took the boy from Göttingen to a little town called Celle, to place him at a school. While stopping at an inn Eugene stated to his father his delight in having solved some little problem in grammar. His father, with eyes brightened with pleasure, replied: "Yes my son, the pleasure one gets from the solution of such problems is very great, but it is not to be compared with the similar pleasure one derives from the solution of mathematical problems."

But the high hopes were followed by bitter disappointment. In a letter to Bessel (Dec. 31, 1831) Gauss says of himself: "Aber Ihr armer Freund ist seit anderthalb Jahren das Opfer der schwersten häuslichen Leiden gewesen: den Ausgang des einen ahnen Sie leicht aus der seit vier Monaten gebrauchten Farbe des Siegels; von einem andern, wo möglich noch härtern sehe ich kaum ein Ende ab als meines. Lassen Sie mich davon schweigen. Lähmend haben solche Verhältnisse auf alle meine wissenschaftlichen Beschäftigungen, fast ganz aufhebend auf meine Correspondenz eingewirkt." The first sorrow alluded to was clearly the death of his second wife; the cause of the second sorrow he leaves unexplained, but the facts which we have been able to gather concerning the relation between him and his son Eugene throw light on this point. At this time, when Eugene reached adolescence, it seems that Gauss did not want him or his brothers to attempt mathematics, for the father did not think any of them would surpass him, and he did not wish the name lowered. Apparently he felt the same way about any other line of scientific work, for, while Eugene, after completing the gymnasium, desired to make the study of philology his life-work, the father wanted him to take up law. At this time Eugene was disposed to indulge in the wild life of a Göttingen student. A scar on his face bore witness of his participation in a duel. What that life was we may judge also from the accounts of Bismarck's stormy career at Göttingen, which began about a year after Eugene left the University. An incident happened which resulted in a serious disagreement between father and son. Eugene gave an elaborate supper to his fellow-students and sent the bill to his father. When the latter reproached his son for this, Eugene suddenly concluded that he would leave Germany and come to America. He started off without bidding the family good-bye or making any preparation for his journey. When Gauss learned of his son's intention he followed and urged him to return, at the same time telling him that he had brought his trunk and if he was determined to seek his fortune in America he would furnish funds for the journey. The son refused to return home, and the two parted. The young man of nineteen left the land of learning and culture, to expose himself to the dangers and temptations of a new world. Need we marvel if, in sorrow and humiliation, Gauss wrote to Bessel: 'Lassen Sie mich davon schweigen.'

Eugene landed in New York and, after spending what money he had, enlisted as a private in the U. S. army. He was taken to Fort Snelling, near St. Paul, Minn. The post was in charge of General Taylor, and Jefferson Davis was a young officer there. By accident the officers found out that Eugene Gauss was an educated man, and he was put in charge of the post library. About the close of his term of enlistment (five years) his brother Joseph came to this country, as we have seen, to study railway construction. Joseph brought letters to General Winfield Scott and thought he could obtain for Eugene a commission in the regular army, if he desired it. But

Eugene had other plans; he entered the employ of the American Fur Company, on the head waters of the Mississippi and Missouri Rivers. There he learned to speak the Sioux language with ease, and assisted a missionary named Pond in preparing a Sioux alphabet. While there Eugene wrote to his father that he had met the French astronomer Nicollet. The latter was attracted to young Gauss by hearing someone pronounce his name and, upon inquiry, discovered that he was the son of the mathematician. Nicollet formed a plan to conduct an expedition across the continent to the Pacific, where he expected to take ship and go by water to Europe. Eugene was to go with him, but the enterprise was defeated by Nicollet's death. In the first letter printed below, Gauss refers to Nicollet and attributes to him a sensational article on moon hoax, which appeared in 1835 in the New York *Sun*. It purported to be written by Richard Adams Locke, but De Morgan, in his 'Budget of Paradoxes,' holds, as does Gauss, that its real author was J. N. Nicollet.

About 1840 Eugene settled at St. Charles, Mo., where he resided until about 1885, when he removed to a farm in Boone County, Mo., near Columbia. He died in 1896. In St. Charles Eugene engaged in mercantile pursuits. In 1844 he married Henrietta Fawcett, who is still living, being now in her 82d year. They had seven children, two of whom have died. Of interest is the following letter written by the mathematician Gauss, to his son, just before the latter's marriage:

"Mein lieber Sohn:

Die in Deinen beiden Briefen an mich und Theresen enthaltene Anzeige von Deiner beschlossenen und nahe bevorstehenden Verheirathung habe ich in mehrern Beziehungen mit Vergnügen aufgenommen. Bei der Unmöglichkeit, über Verhältnisse und Personen aus eigner Kenntniss ein Urtheil zu bilden, überlasse ich mich gerne dem Vertrauen, dass Dein Alter und Deine Erfahrungen, Dich vor solchen Täuschungen, in welche wohl unbesonnene und unerfahrene Jünglinge verfallen, bewahren. Ich wünsche und hoffe daher herzlich, dass alle die schönen Tugenden, welche Du von Deiner künftigen Lebensgefährtin rühmst, und die den Mangel äusserer Glücksgüter für einen verständigen und auf eigenen Füssen feststehend sich fühlenden Mann wohl aufwiegen, sich stets als ächt bewähren werden, zugleich aber auch, dass Du Dich des Besitzes eines solchen Schatzes immer würdig beweisen werdest, und dass so die Verbindung zu Euer beider wahrem Glück gereiche.

Auch Deine beiden Brüder haben sich Lebensgefährtinnen ohne Vermögen gewählt. Dass Du darüber, auch mit so vieler Leichtmüthigkeit hinwegsetzest ist mir auch in sofern angenehm, als ich darin eine Bestetigung von dem voraussetze, was Herr Eggers vor einigen Monaten hier äusserte, nemlich, dass Deine Umstände und Handelsgeschäfte in einem prosperirenden Zustande sind. Hrn. Eggers Besuch war übrigens so kurz, dass ich über so vieles was ich gerne näher wüsste, nur sehr unvollkommene oder gar keine Kenntniss erhalten habe. So weiss ich namentlich von Deinem Geschäfte bloss im Allgemeinen, dass es ein Kaufmännisches sei, und dass Du mit einem Compagnon associirt seiest; näheres aber z. B. welcher Art jene Geschäfte, ob der Compagnon ein Deutscher oder ein Amerikaner sei &c. habe ich nicht erfahren.

In einem Deiner früheren Briefe erwähntest Du einmal eines jungen Franzosen Namens Nicollet, mit dem Du in Bekanntschaft gekommen seiest. Derselbe war vor Zeiten Gehülfe an der Pariser Sternwarte und hat einige nicht verdienstlose Arbeiten geliefert. Aus welchem Grunde er Frankreich hat verlassen müssen, habe ich nicht erfahren.* Später (etwa vor 7 oder 8 Jahren) hat er (ich weiss nicht mehr ob anonym oder mit Nennung des Namens) in einer Amerikanischen Zeitung oder Journal einen possenreisserischen Artikel über angebliche wahrhaft unsinnige Entdeckungen, die Herschel auf dem Vorgebirge der guten Hoffnung gemacht haben sollte, geliefert. Dieser Artikel wurde sogar seiner Zeit ins Deutsche übersetzt, und gab einen merkwürdigen Beweis, wie sehr plump eine Mystification sein kann, ohne die Kraft zu verlieren, viele Leute zu Narren zu haben. Dieser Nicollet nun soll vor Kurzem in Amerika gestorben sein. Ich möchte wohl wünschen, über seinen dortigen Lebenslauf etwas mehr zu erfahren. Auch ein anderer Astronom, aus der Schweiz gebürtig, aber seit fast 50

* Laplace once recommended Nicollet for membership in the French Academy, but he failed of election because of Arago's opposition. "A short time afterwards M. Nicollet had run away to America, and the Bureau of Longitude had a warrant passed to expel him ignominiously from its bosom."—From *Arago's Autob ography.*

Jahren, in Amerika einheimisch geworden, mit dem ich wohl von Zeit zu Zeit einige Korrespondenz gepflogen habe, nemlich Rudolf Hassler, Chef der Amerikanischen Messungen, ist, wie ich aus öffentlichen Nachrichten erfahre, vor kurzem gestorben.

Unter den herzlichsten Wünschen für das dauernde Glück Eurer Verbindung

Dein treuer Vater

C. F. GAUSS.

GÖTTINGEN, 15 Februar, 1848.

P. S. Briefe über Liverpool gehen weder sicherer noch schneller als über Havre, kosten aber hier jedesmal ein enormes Porto, etwa 3 mal so viel wie über Havre. Schicke daher künftig keine Briefe über England sondern immer via Havre.

The correspondence between Gauss and Hassler, the organizer and first superintendent of the U. S. Coast Survey, would be of interest, no doubt, but none of the letters are in possession either of the U. S. Coast Survey or of Mrs. Simon Newcomb, who is a grandchild of Hassler.

The original of Gauss's letter, given above, is now in the Lick Observatory. The present writer has a photograph of it. A strange thing in connection with it is the fact that Gauss, who possessed such wonderful power over numbers as to create a new Theory of Numbers, should make a mistake in so simple a matter as a date. The number '1848' should be '1844.' This is evident from the postmark on the back of the letter as well as from Theresa's letters and from the record of the marriage of Eugene, contained in the office of the Recorder of St. Charles County, where the marriage took place.

Another letter from Gauss to Eugene is now in the possession of a grandchild, Charles Henry Gauss, of Columbia, Mo. It is as follows:

LIEBER EUGEN:

Ich kann nicht unterlassen, Deinen vom 16 Mai datirten und am 30 Junius hier eingegangenen Brief wenigstens mit einigen Zeilen zu erwiedern, obwohl ich aus zwei Ursachen zur Kürze gezwungen werde, nemlich, erstlich, weil Therese wegen Absendung des Pakets pressirt ist, und zweitens, weil ich ziemlich unwohl bin, und den grössern Theil des Tages auf dem Sofa liegend zubringen muss. Grossentheils mag dies die Folge der unerträglichen Hitze sein, bei der ich immer sehr leide, und die in diesem Sommer grösser ist, als ich je in meinem ganzen Leben erduldet zu haben mich erinnere. Nach den öffentlichen Blättern scheint diese Hitze in Europa ganz allgemein zu sein.

Dass ich nun auch von Deiner Seite in der Neuen Welt einen Enkel habe, ist mir sehr erfreulich; in der Alten Welt wird mein Name wohl aussterben, da Josephs Ehe schon ins siebente Jahr kinderlos geblieben ist. Aller Wahrscheinlichkeit wird Joseph nun mit Nächstem in eine veränderte Lage kommen, ihm selbst mehr zusagend, als eine Lieutenantsstelle in Friedenszeit, und mir selbst auch aus dem Grunde lieb, weil er räumlich mir näher kommt. Er ist nemlich bestimmt, mit in unser Eisenbahn. Directorium einzutreten, wobei er seinen Abschied aus dem Militär und sein gewöhnliches Domicilium in Hannover wird nehmen müssen, obwohl er dabei während eines grossen Theils des Jahres auf Reisen zuzubringen haben wird. Er ist in diesem Augenblick in Stade, um seine Frau nach Hannover abzuhohlen.

Dass Deine Geschäfte gut prosperiren freuet mich sehr, aber in einem neulich von Deiner Grossmutter erhaltenen Briefe ist eine etwas unverständliche Andeutung, als ob Du gewillet seiest, jene aufzugeben auf das Land zu ziehen, und von da aus bloss Grosshandel zu treiben. Da in Deinem Briefe an mich darüber gar Nichts vorkommt, so vermuthe ich, dass jene Äusserung wenigstens zum Theil auf einem Misverständnisse beruhet. Übrigens haben wir vor Kurzem ein tangibles Zeichen Deiner Geschäftsthätigkeit erhalten, da Herr Westhof uns ein Fässchen Mehl aus der Mühle Gauss & Weidner zugeschickt hat, welches Therese sehr lobt, als besser, wie alles hiesige.

Zufällig hatten wir gleichzeitig einen Topf Butter aus dem Altenlande von Josephs Frau erhalten, und es fehlten also zu einer Omelette abseiten meiner Kinder aus fremden Landen nur noch die Eier aus Wilhelms Hühnerstalle.

Ueber das Daguerrebild, welches Deine liebe Frau Theresen geschickt hat, haben wir uns sehr gefreut; die Arbeit ist feiner, als ich sie an einem in Europa gemachten Daguerrebilde sonst gesehen habe. Therese erwiedert es mit ihrem Daguerrebild, welches in zwei Exemplaren, eines für Dich, eines für Wilhelm Herr Angetrodt mitbringt. Ausserdem und zu gleicher Distribution bringt er zwei Lithographien von meinem Portrait mit; sie sind im vorigen Winter von einem Oelgemälde abgenommen, welches vor 6-Jahren hier gemacht ist. (Das Original dieses Oe h gemäldes von einem Kopenhagner Künstler kam nac

Petersburg, und eine Copie für Herrn Sartorius blieb hier, wonach jene Lithographie gemacht ist. Man fand das Gemälde damahls sehr ähnlich ; jetzt werde ich ihm wohl unähnlich geworden sein.

Auch für die Karte von Missouri und Arkansas, welche mit jenem Bilde zugleich ankam, habe ich Dir noch zu danken.

Dass Ewald noch im vorigen Jahre sich wieder verheirathet hat, wird Dir wahrscheinlich die Grossmutter geschrieben haben. Mit herzlichen Wünschen für Dein Wohlergehen

Dein treuer Vater,
C. F. Gauss.

Göttingen,
den 9ten August, 1846.

An account of Gauss's children is interesting from the standpoint of heredity. None inherited Gauss's mathematical power. Eugene resembled his father mentally more than the others. Like his father, he possessed great linguistic powers. Before his death he expressed it as his opinion—and from all I can gather it is probable—that had he continued his philological studies in Germany he would have secured a chair in a University. He spoke French so well that he was taken for a Frenchman. The English and the Sioux language he spoke to perfection. He read the New Testament in the original. At the age of forty he had become deeply interested in religion, and thereafter he gave much attention to Biblical and theological reading. His deep religious convictions were shown by his expression of satisfaction with his coming to America, because if he had not done so he might never have been led to profess the religion of Christ.

Eugene was not the person to push himself to the front. He lived over ten years near the seat of the University of Missouri, without seeking the acquaintance of any member of the Faculty. Milton Updegraff, the professor of astronomy, accidentally heard of him through one of his students and visited him (about 1890). He told Professor Updegraff that his father first thought of the heliotrope while walking with him and noticing the light of the setting sun reflected from a window of a distant house.* Eugene possessed mathematical ability, but he never studied the higher branches. When he was over eighty years old and had become blind, he used to entertain himself by making long arithmetical calculations in his head. For instance, he computed the amount to which one dollar would grow, if compounded annually at the rate of 4% interest from the time of Adam to the present, assuming this to be 6,000 years. This, if in gold, would make a cubic mass so large that it would require light quadrillions of years to pass along one side of it.† This mental computation is so startling as to be almost beyond belief. The only assistance he had was from his son Theodore (now deceased), who was asked to write down, at intervals during the several days he was so occupied, the results that marked the different stages of his work. Eugene arrived at his result by ordinary arithmetic. His son preserved the paper on which were written the long lines of figures which he thought he might not be able to retain in his memory. On the sheet are several memoranda that are interesting. For instance, Eugene directed his son to write down the figures :

```
12345678905718217803 9
          3680824926969613857
-----------------------------
12345678906086300296596961385 7
                              X
```

The second line of figures was written down several days after the first and added to the upper one by Theodore. His father had directed him to begin the second line of figures by placing the figure 3 under the second 7 of the upper line. In reading off the result of this addition Theodore read 7 in place of the 8 marked with an X. Eugene detected the error and his son made the

* See also Bessel's letter to Gauss, Oct. 18, 1821.

† The answer exceeds *five quadrillions* of years, French numeration.

correction, showing that the blind and aged man was able to retain in his mind the long line of thirty figures. This wonderful computation, if it does not demonstrate great mathematical ability, certainly shows an extraordinary memory. We involuntarily ask: What might Eugene not have achieved, had his experiences in life been such as to draw out his faculties to the fullest extent?

Eugene's younger brother Wilhelm came to this country in 1837, immediately after his marriage to a niece on the mother's side to the astronomer Bessel. Wilhelm wished to make farming his vocation and he believed the opportunities were better in the United States than in Germany. For twenty years he was almost continually engaged in farming in Missouri; then he entered the wholesale shoe business in St. Louis, in which he continued until his death, in 1879. Of his eight children six are now living; some are in business; two are Presbyterian clergymen.

Near the beginning of this article we quoted from a letter, written by Theresa to her brother Eugene. I have seen another of her letters (dated May 16, 1855), in which she gives an account of the last illness of her illustrious father. From the long letter we translate the following:

"The last year of suffering—full of sickness demanding constant attendance—has bound me still more closely to him. During the last weeks there was hardly a moment, day or night, when he permitted me to be away from him, and he expressed the desire that we might not be separated even by death, for only a few days before he died he said to me: 'The best and greatest that God could grant us would be this one favor, that we two on the same day might die together.' * * *

"My last letter to you, dated, I believe, April 30, '53, is two years old, and if at that time I wrote that father's health was no longer quite robust, it nevertheless did not cause any unusual anxiety. But in the course of the summer following he began to complain to such an extent as to cause alarm. Part of the time he suffered much, and, his strength failing rapidly, I, full of apprehension, besought him in vain to call in a physician. Not till January, 1854, as the disease in a few weeks had made rapid progress, did he consent. The physician, who has since with unremitting love, care and sympathy attended him, lessened his suffering where cure was impossible, and doubtless somewhat prolonged his life, declared to me positively, after the first visit, that his condition was dangerous and hopeless. He recognized the disease at once as a heart trouble, which probably had been coming on for years, in course of which there had been an accumulation of water about the heart, which in a few weeks also extended to other parts of the body. At that time the disease advanced rapidly and left little hope, but under the careful treatment of our loving physician, Dr. Baum, some improvement followed like a miracle. Some symptoms of the disease disappeared entirely, and father was able to go out for short distances, though only slowly and with immediate exhaustion. * * * * But suddenly in November the old trouble returned in more decisive form, increased from day to day, and at the beginning of the present year the physician said to me the life of our beloved one would be of only short duration. The last weeks of suffering were terrible, as the disease of dropsy in general is terrible, because it visibly approaches death inch by inch. But father has borne all his suffering to the end with unvarying, touching serenity, friendliness and patience. Entirely hopeless he never was; he always believed in the possibility of recovery so long as one spoke encouragingly to him. Ah! how difficult this has often been, when I, hopeless, knew the nearness of death! He never lost complete consciousness. Four hours before his death he still knew me, when, for the last time, he took a drink from my hand, drew my hand toward him and, kissing it, looked lovingly at me. He then closed his eyes and seemed to sleep, but I believe he did not sleep, but that his spirit, clear and conscious as ever, had freed itself from its earthly shell and had gone to its heavenly home."

We close with a letter written to Eugene Gauss by Professor Ernst Schering, C. F. Gauss's successor at the observatory in Göttingen, who himself has since joined the ranks of the departed:

STERNWARTE, GÖTTINGEN, 1892, Nov. 21.

SEHR GEEHRTER HERR GAUSS:

Wie Sie aus beifolgendem Correcturbogen ersehen werden, sind wir hier in Göttingen im Begriffe ein Denkmal für Ihren berühmten Vater zu errichten. In der Meinung, dass Sie wünschen werden, Ihren Namen in der Aufforderung der Mathematiker, As-

tronomer und Physiker gedruckt zu sehen, habe ich, als Nachfolger Ihres Vaters, jetzt in seiner Dienstwohnung befindlich, und als Herausgeber seiner grossen Werke, mir erlaubt Ihren Namen mit in die Liste einsetzen zu lassen. Es war nicht mehr Zeit Sie um Ihre Erlaubnis dazu zu fragen, aber es kann bei mir kein Zweifel sein über Ihre Genehmigung. Gerne werde ich mir erlauben, Ihnen weiteren Bericht über die Denkmalsfrage abzustatten, so bald etwas definitives feststeht.

Der Prinz Albrecht von Preussen, Prinz Regent vom Herzogthum Braunschweig, Rector Magnificentissimus von der Universität Göttingen, hat sich bereit finden lassen, das Protectorat der Commission für das Denkmal zu übernehmen. Er hat befohlen, dass aus Landesmitteln des Herzogthums Braunschweig 3000 Mk. für das Denkmal gegeben werden. Das ist ja ein sehr guter Anfang. In den Zeitungen habe ich die Notiz gelesen :

Gauss, E. F. L. erster Assistent von Frederik H. Hild dem Librarian of the Chicago Public Library. Gehört dieser Gauss auch zu der berühmten Familie?*

Da das Deutsche Reich sich auch amtlich an der grossen Ausstellung in Chicago betheiligt, so wird wahrscheinlich das Post—und Telegraphen—Museum in Berlin unter dem Reichsekretair von Stephan auch die Hauptstücke seiner geschichtlichen Sammlung dorthin senden. Darunter findet sich ein Gemälde von dem grossen Gauss und eine Reproduction sein s ersten Telegraphen. Jenes Gemälde ist Gauss sehr ähnlich, aber noch schöner finde ich das Gemälde, welches sich hier in seinem Erdmagnetischen Observatorium unter meinem Gewahrsam befindet. Es ist von der Preussischen Regierung zum 150 jährigen Jubilaeum der Universität Göttingen 1887 dem Institute geschenkt worden. Ueberhaupt war dieses Jubilaeum ein grossartiges Fest zur Verherrlichung von Gauss. Keine der vielen Tischreden, keine Festrede, keine Predigt wurde gehalten, ohne dass sein Name genannt und seine Erfindung des Electrischen Telegraphen erwähnt worden wäre. Seit jener Zeit befindet sich auch seine Marmortafel an der Sternwarte, Abtheilung des Erdmagnetischen Observatorium, mit der Aufschrift

Erster electrischer Telegraph
Gauss—Weber
Ostern, 1833

Mit den ergebensten Empfehlungen zeichne ich mich Ihr Ernst Schering,

Herausgeber der Gauss'schen Werke. Gemeinrath u. Professor.

* Mr. Robert Gauss, a son of Eugene Gauss and now managing editor of the *Denver Republican*, informs me that the E. F. L. Gauss in question is not a descendant of Gauss the mathematician. Schering's letter is in the possesssion of Robert Gauss, through whose kindness the writer was permitted to make a copy of it.

Florian Cajori.

Colorado College, Colorado Springs.

THE AGE OF THE EARTH AS AN ABODE FITTED FOR LIFE.

II.

PROBABLE ORIGIN OF GRANITE.

§ 26. Upon the suppositions we have hitherto made we have, at the stage now reached, all round the earth at the same time a red-hot or white-hot surface of solid granules or crystals with interstices filled by the mother liquor still liquid, but ready to freeze with the slightest cooling. The thermal conductivity of this heterogeneous mass, even before the freezing of the liquid part, is probably nearly the same as that of ordinary solid granite or basalt at a red heat, which is almost certainly* somewhat less than the thermal conductivity of igneous rocks at ordinary temperatures. If you wish to see for yourselves how quickly it would cool when wholly solidified take a large macadamizing stone, and heat it red hot in an ordinary coal fire. Take it out with a pair of tongs and leave it on the hearth, or on a stone slab at a distance from the fire, and you will see that in a minute or two, or perhaps in less than a minute, it cools to below red heat.

§ 27. Half an hour† after solidification reached up to the surface in any part of the earth, the mother liquor among the granules must have frozen to a depth of several centimeters below the surface and must have cemented together the granules and crystals, and so formed a crust of primeval granite, comparatively cool at its upper surface, and red hot to white hot, but still

* Proc. R. S., May 30, 1895.

† Witness the rapid cooling of lava running red hot or white hot from a volcano, and after a few days or weeks presenting a black, hard crust strong enough and cool enough to be walked over with impunity.

all solid, a little distance down; becoming thicker and thicker very rapidly at first; and after a few weeks certainly cold enough at its outer surface to be touched by the hand.

PROBABLE ORIGIN OF BASALTIC ROCK.*

§ 28. We have hitherto left, without much consideration, the mother liquor among the crystalline granules at all depths below the bottom of our shoaling lava ocean. It was probably this interstitial mother liquor that was destined to form the basaltic rock of future geological time. Whatever be the shapes and sizes of the solid granules when first falling to the bottom, they must have lain in loose heaps with a somewhat large proportion of space occupied by liquid among them. But, at considerable distances down in the heap, the weight of the superincumbent granules must tend to crush corners and edges into fine powder. If the snow shower had taken place in air we may feel pretty sure (even with the slight knowledge which we have of the hardnesses of the crystals of feldspar, mica and hornblende, and of the solid granules of quartz) that, at a depth of 10 kilometers, enough of matter from the corners and edges of the granules of different kinds, would have been crushed into powder of various degrees of fineness, to leave an exceedingly small proportionate volume of air in the interstices between the solid fragments. But in reality the effective weight of each solid particle, buoyed as it was by hydrostatic pressure of a liquid less dense than itself by not more than 20 or 15 or 10 per cent., cannot have been more than from about one-fifth to one-tenth of its weight in air, and therefore the same degree of crushing effect as would have been experienced at 10 kilometers with air in the interstices, must have been experienced only at depths of from 50 to 100 kilometers below the bottom of the lava ocean.

§ 29. A result of this tremendous crushing together of the solid granules must have been to press out the liquid from among them, as water from a sponge, and cause it to pass upwards through the less and less closely packed heaps of solid particles, and out into the lava ocean above the heap. But, on account of the great resistance against the liquid permeating upwards 30 or 40 kilometers through interstices among the solid granules, this process must have gone on somewhat slowly; and, during all the time of the shoaling of the lava ocean, there may have been a considerable proportion of the whole volume occupied by the mother liquor among the solid granules, down to even as low as 50 or 100 kilometers below the top of the heap, or bottom of the ocean, at each instant. When consolidation reached the surface, the oozing upwards of the mother liquor must have been still going on to some degree. Thus, probably for a few years after the first consolidation at the surface, not probably for as long as one hundred years, the settlement of the solid structure by mere mechanical crushing of the corners and edges of solid granules, may have continued to cause the oozing upwards of mother liquor to the surface through cracks in the first formed granite crust and through fresh cracks in basaltic crust subsequently formed above it.

LEIBNITZ'S CONSISTENTIOR STATUS.

§ 30. When this oozing everywhere through fine cracks in the surface ceases, we have reached Leibnitz's *consistentior status;* beginning with the surface cool and permanently solid and the temperature increasing to 1150° C. at 25 or 50 or 100 meters below the surface.

* See Addendum at end of Lecture.

PROBABLE ORIGIN OF CONTINENTS AND OCEAN DEPTHS OF THE EARTH.

§ 31. If the shoaling of the lava ocean up to the surface had taken place everywhere at the same time, the whole surface of the consistent solid would be the dead level of the liquid lava all round, just before its depth became zero. On this supposition there seems no possibility that our present-day continents could have risen to their present heights, and that the surface of the solid in its other parts could have sunk down to their present ocean depths, during the twenty or twenty-five million years which may have passed since the *consistentior status* began or during any time however long. Rejecting the extremely improbable hypothesis that the continents were built up of meteoric matter tossed from without, upon the already solidified earth, we have no other possible alternative than that they are due to heterogeneousness in different parts of the liquid which constituted the earth before its solidification. The hydrostatic equilibrium of the rotating liquid involved only homogeneousness in respect to density over every level surface (that is to say, surface perpendicular to the resultant of gravity and centrifugal force); it required no homogeneousness in respect to chemical composition. Considering the almost certain truth that the earth was built up of meteorites falling together, we may follow in imagination the whole process of shrinking from gaseous nebula to liquid larva and metals, and solidification of liquid from central regions outwards, without finding any thorough mixing up of different ingredients, coming together from different directions of space—any mixing up so thorough as to produce even approximately chemical homogeneousness throughout every layer of equal density. Thus we have no difficulty in understanding how even the gaseous nebula, which at one time constituted the matter of our present earth, had in itself a heterogeneousness from which followed by dynamical necessity Europe, Asia, Africa, America, Australia, Greenland and the Antarctic Continent, and the Pacific, Atlantic, Indian and Arctic Ocean depths, as we know them at present.

§ 32. We may reasonably believe that a very slight degree of chemical heterogeneousness could cause great differences in the heaviness of the snow shower of granules and crystals on different regions of the bottom of the lava ocean when still 50 or 100 kilometers deep. Thus we can quite see how it may have shoaled much more rapidly in some places than in others. It is also interesting to consider that the solid granules, falling on the bottom, may have been largely disturbed, blown as it were into ridges (like rippled sand in the bed of a flowing stream, or like dry sand blown into sand-hills by wind) by the eastward horizontal motion which liquid descending in the equatorial regions must acquire, relatively to the bottom, in virtue of the earth's rotation. It is, indeed, not improbable that this influence may have been largely effective in producing the general configuration of the great ridges of the Andes and Rocky Mountains and of the West Coasts of Europe and Africa. It seems, however, certain that the main determining cause of the continents and ocean-depths was chemical differences, perhaps very slight differences, of the material in different parts of the great lava ocean before consolidation.

§ 33. To fix our ideas let us now suppose that over some great areas such as those which have since become Asia, Europe, Africa, Australia and America, the lava ocean had silted up to its surface, while in other parts there still were depths ranging down to 40 kilometers at the deepest. In a very short time, say about twelve years according to our former estimate (§ 24), the

whole lava ocean becomes silted up to its surface.

§ 34. We have not time enough at present to think out all the complicated actions, hydrostatic and thermodynamic, which must accompany, and follow after, the cooling of the lava ocean surrounding our ideal primitive continent. By a hurried view, however, of the affair we see that in virtue of, let us say, 15 per cent. shrinkage by freezing, the level of the liquid must, at its greatest supposed depth, sink six kilometers relatively to the continents, and thus the liquid must recede from them, and their bounding coast-lines must become enlarged. And just as water runs out of a sandbank, drying when the sea recedes from it on a falling tide, so rivulets of the mother liquor must run out from the edges of the continents into the receding lava ocean. But, unlike sandbanks of incoherent sand permeated by water remaining liquid, our uncovered banks of white-hot solid crystals, with interstices full of the mother liquor, will, within a few hours of being uncovered, become crusted into hard rock by cooling at the surface, and freezing of the liquor, at a temperature somewhat lower than the melting temperatures of any of the crystals previously formed. The thickness of the wholly solidified crust grows at first with extreme rapidity, so that in the course of three or four days it may come to be as much as a meter. At the end of a year it may be as much as ten meters; with a surface, almost, or quite, cool enough for some kinds of vegetation. In the course of the first few weeks the régime of conduction of heat outwards becomes such that the thickness of the wholly solid crust, as long as it remains undisturbed, increases as the square root of the time; so that in 100 years it becomes 10 times, in 25 million years 5,000 times, as thick as it was at the end of one year; thus, from one year to 25 million years after the time of surface freezing, the thickness of the wholly solid crust might grow from 10 meters to 50 kilometers. These definite numbers are given merely as an illustration, but it is probable that they are not enormously far from the truth in respect to what has happened under some of the least disturbed parts of the earth's surface.

§ 35. We have now reached the condition described above in § 30, with only this difference, that instead of the upper surface of the whole solidified crust being level we have in virtue of the assumptions of §§ 33, 34, inequalities of 6 kilometers from highest to lowest levels, or as much more than 6 kilometers as we please to assume it.

§ 36. There must still be a small, but important, proportion of mother liquor in the interstices between the closely packed uncooled crystals below the wholly solidified crust. This liquor, differing in chemical constitution from the crystals, has its freezing-point somewhat lower, perhaps very largely lower, than the lowest of their melting-points. But, when we consider the mode of formation (§ 25) of the crystals, from the mother liquor, we must regard it as still always a solvent ready to dissolve, and to redeposit, portions of the crystalline matter, when slight variations of temperature or pressure tend to cause such actions. Now as the specific gravity of the liquor is less, by something like 15 per cent., than the specific gravity of the solid crystals, it must *tend* to find its way upwards, and will actually do so, however slowly, until stopped by the already solidified impermeable crust, or until itself becomes solid on account of loss of heat by conduction outwards. If the upper crust were everywhere continuous and perfectly rigid the mother liquor must, inevitably, if sufficient time be given, find its way to the highest places of the lower boundary of the crust, and there form gigantic pockets of liquid lava tending to

break the crust above it and burst up through it.

§ 37. But in reality the upper crust cannot have been infinitely strong; and, judging alone from what we know of properties of matter, we should expect gigantic cracks to occur from time to time in the upper crust tending to shrink as it cools and prevented from lateral shrinkage by the non-shrinking uncooled solid below it. When any such crack extends downwards as far as a pocket of mother liquor underlying the wholly solidified crust, we should have an outburst of trap rock or of volcanic lava just such as have been discovered by geologists in great abundance in many parts of the world. We might even have comparatively small portions of high plateaus of the primitive solid earth raised still higher by outbursts of the mother liquor squeezed out from below them in virtue of the pressure of large surrounding portions of the superincumbent crust. In any such action, due to purely gravitational energy, the center of gravity of all the material concerned must sink, although portions of the matter may be raised to greater heights; but we must leave these large questions of geological dynamics, having been only brought to think of them at all just now by our consideration of the earth antecedent to life upon it.

§ 38. The temperature to which the earth's surface cooled within a few years after the solidification reached it must have been, as it is now, such that the temperature at which heat radiated into space during the night exceeds that received from the sun during the day by the small difference due to heat conducted outwards from within.* One year after the freezing of the granitic interstitial mother liquor at the earth's surface in any locality the average temperature at the surface might be warmer, by 60° or 80° Cent., than if the whole interior had the same average temperature as the surface. To fix our ideas, let us suppose at the end of one year the surface to be 80° warmer than it would be with no underground heat; then at the end of 100 years it would be 8° warmer, and at the end of 10,000 years it would be ·8 of a degree warmer, and at the end of 25 million years it would be ·016 of a degree warmer, than if there were no underground heat.

§ 39. When the surface of the earth was still white-hot liquid all round, at a temperature fallen to about 1200° Cent., there must have been hot gases and vapor of water above it in all parts, and possibly vapors of some of the more volatile of the present known terrestrial solids and liquids, such as zinc, mercury, sulphur, phosphorus. The very rapid cooling which followed instantly on the solidification at the surface

* Suppose, for example, the cooling and thickening of the upper crust has preceeded so far that at the surface, and, therefore, approximately for a few decimetres below the surface, the rate of augmentation of temperature downwards is one degree per centimeter. Taking as a rough average ·005 c. g. s. as the thermal conductivity of the surface rock, we should have for the heat conducted outwards ·005 of a gramme water thermal unit Centigrade per sq. cm. per sec. (Kelvin Math. and Phys. Papers, Vol. III., p. 226). Hence, if (ibid. p. 223) we take $\frac{1}{8000}$ as the radiational emissivity of rock and atmosphere of gases and watery vapor above it radiating heat into the surrounding vacuous space (æther), we find $8000 \times \cdot 005$ or 40 degrees Cent. as the excess of the mean surface temperature above what it would be if no heat were conducted from within outwards. The present augmentation of temperature downwards may be taken as 1 degree Cent. per 27 meters as a rough average derived from observations in all parts of the earth where underground temperature has been observed. (See British Association Reports from 1868 to 1895. The very valuable work of this Committee has been carried on for these twenty-seven years, with great skill, perseverance and success, by Professor Everett, and he promises a continuation of his reports from time to time.) This, with the same data for conductivity and radiational emissivity as in the preceding calculation, makes 40°/2700 or 0.0148° Cent. per centimeter as the amount by which the average temperature of the earth's surface is at present kept up by underground heat.

must have caused a rapid downpour of all the vapors other than water, if any there were; and, a little later, rain of water out of the air, as the temperature of the surface cooled from red heat to such moderate temperatures as 40° and 20° and 10° Cent. above the average due to sun heat and radiation into the ether around the earth. What that primitive atmosphere was, and how much rain of water fell on the earth in the course of the first century after consolidation, we cannot tell for certain; but Natural History and Natural Philosophy give us some foundation for endeavors to discover much towards answering the great questions: Whence came our present atmosphere of nitrogen, oxygen and carbonic acid? Whence came our present oceans and lakes of salt and fresh water? How near an approximation to present conditions was realized in the first hundred centuries after consolidation of the surface.

§ 40. We may consider it as quite certain that nitrogen gas, carbonic acid gas and steam, escaped abundantly in bubbles from the mother liquor of granite, before the primitive consolidation of the surface, and from the mother liquor squeezed up from below in subsequent eruptions of basaltic rock, cause all, or nearly all, specimens of granite and basaltic rock which have been tested by chemists in respect to this question,* have been found to contain, condensed in minute cavities within them, large quantities of nitrogen, carbonic acid and water. It seems that in no specimen of granite or basalt tested has chemically free oxygen been discovered, while in many, chemically free hydrogen has been found, and either native iron or magnetic oxide of iron in those which do contain hydrogen. From this it might seem probable that there was no free oxygen in the primitive atmosphere, and that if there was free hydrogen it was due to the decomposition of steam by iron or magnetic oxide of iron. Going back to still earlier conditions we might judge that, probably, among the dissolved gases of the hot nebula which became the earth, the oxygen all fell into combination with hydrogen and other metallic vapors in the cooling of the neubla, and that, although it is known to be the most abundant material of all the chemical elements constituting the earth, none of it was left out of combination with other elements to give free oxygen in our primitive atmosphere.

§ 41. It is, however, possible, although it might seem not probable, that there was free oxygen in the primitive atmosphere. With or without free oxygen, however, *but with sunlight*, we may regard the earth as fitted for vegetable life as now known in some species, wherever water moistened the newly solidified rocky crust cooled down below the temperature of 80° or 70° of our present Centigrade thermometric scale a year or two after solidification of the primitive lava had come up to the surface. The thick, tough, velvety coating of living vegetable matter, covering the rocky slopes under hot water flowing direct out of the earth at Banff (Canada),* lives without help from any ingredients of the atmosphere above it, and takes from the water and from carbonic acid or carbonates, dissolved in it, the hydrogen and carbon needed for its own growth by the dynamical power of sunlight; thus leaving free oxygen in the water to pass ultimately into the air. Similar vegetation is found abundantly on the terraces of the Mammoth hot springs and on the beds of the hot-water streams flowing from the Geysers in the Yellowstone National Park of the United States. This vegetation, consisting of confervæ, all grows

* See, for example, Tilden, Proc. R. S. February 4, 1897: 'On the Gases Enclosed in Crystalline Rocks and Minerals.'

* Rocky Mountains Park of Canada, on the Canadian Pacific Railway.

under flowing water at various temperatures, some said to be as high as 74° Cent. We cannot doubt but that some such confervæ, if sown or planted in a rivulet or pool of warm water in the early years of the first century of the solid earth's history, and, if favored with sunlight, would have lived, and grown, and multiplied, and would have made a beginning of oxygen in the air, if there had been none of it before their contributions. Before the end of the century, if sun-heat, and sunlight, and rainfall were suitable, the whole earth not under water must have been fitted for all kinds of land plants which do not require much or any oxygen in the air, and which can find, or make, place and soil for their roots on the rocks on which they grow; and the lakes or oceans formed by that time must have been quite fitted for the life of many or all of the species of water plants living on the earth at the present time. The moderate warming, both of land and water, by underground heat, towards the end of century, would probably be favorable rather than adverse to vegetation, and there can be no doubt but that if abundance of seeds of all species of the present day had been scattered over the earth at that time an important proportion of them would have lived and multiplied by natural selection of the places where they could best thrive.

§ 42. But if there was no free oxygen in in the primitive atmosphere or primitive water several thousands, possibly hundreds of thousands, of years must pass before oxygen enough for supporting animal life, as we now know it, was produced. Even if the average activity of vegetable growth on land and in water over the whole earth was, in those early times, as great in respect to evolution of oxygen as that of a Hessian forest, as estimated by Liebig* 50 years ago, or of a cultivated English hayfield of the present day, a very improbable supposition, and if there were no decay (*eremacausis*, or gradual recombination with oxygen) of the plants or of portions, such as leaves falling from plants, the rate of evolution of oxygen, reckoned as three times the weight of the wood or the dry hay produced, would be only about 6 tons per English acre per annum or $1\frac{1}{2}$ tons per square meter per thousand years. At this rate it would take only 1533 years, and, therefore, in reality a much longer time would almost certainly be required, to produce the 2.3 tons of oxygen which we have at present resting on every square meter of the earth's surface, land and sea.* But probably quite a moderate number of hundred thousand years may have sufficed. It is interesting, at all events, to remark that, at any time, the total amount of combustible material on the earth, in the form of living plants or their remains left dead, must have been just so much that to burn it all would take either the whole oxygen of the atmosphere or the excess of oxygen in the atmosphere at the time above that, if any, which there was in the beginning. This we can safely say, because we almost certainly neglect nothing considerable in comparison with what we assert when we say that the free oxygen of the earth's atmosphere is augmented only by vegetation liberating it from carbonic acid and water, in virtue of the power of sunlight, and is diminished only by virtual burning† of the

* Liebig, 'Chemistry in its application to Agriculture and Physiology.' English, 2d ed., edited by Playfair, 1842.

* In our present atmosphere, in average conditions of barometer and thermometer, we have, resting on each square meter of the earth's surface, ten tons total weight, of which 7.7 is nitrogen and 2.3 is oxygen.

† This 'virtual burning' includes eremacausis of decay of vegetable matter, if there is any eremacausis of decay without the intervention of microbes or other animals. It also includes the combination of a portion of the food with inhaled oxygen in the regular animal economy of provision for heat and power.

vegetable matter thus produced. But it seems improbable that the average of the whole earth—dry land and sea bottom—contains at present coal, or wood, or oil, or fuel of any kind, originating in vegetation, to so great an amount as .767 of a ton per square meter of surface; which is the amount, at the rate of one ton of fuel to three tons of oxygen, that would be required to produce the 2.3 tons of oxygen per square meter of surface which our present atmosphere contains. Hence it seems probable that the earth's primitive atmosphere must have contained free oxygen.

§ 43. Whatever may have been the true history of our atmosphere it seems certain that if sunlight was ready the earth was ready, both for vegetable and animal life, if not within a century, at all events within a few hundred centuries, after the rocky consolidation of its surface. But was the sun ready? The well-founded dynamical theory of the sun's heat carefully worked out and discussed by Helmholtz, Newcomb and myself,* says NO if the consolidation of the earth took place as long as 50 million years; the solid earth must in that case have waited 20 or 50 million years for the sun to be anything nearly as warm as he is at present. If the consolidation of the earth was finished 20 or 25 million years ago the sun was probably ready, though probably not then quite so warm as at present, yet warm enough to support some kind of vegetable and animal life on the earth.

§ 44. My task has been rigorously confined to what, humanly speaking, we may call the fortuitous concourse of atoms, in the preparation of the earth as an abode fitted for life, except in so far as I have referred to vegetation, as possibly having been concerned in the preparation of an atmosphere suitable for animal life as we now have it. Mathematics and dynamics fail us when we contemplate the earth, fitted for life but lifeless, and try to imagine the commencement of life upon it. This certainly did not take place by any action of chemistry, or electricity, or crystalline grouping of molecules under the influence of force, or by any possible kind of fortuitous concourse of atoms. We must pause, face to face with the mystery and miracle of the creation of living creatures.

* See 'Popular Lectures and Addresses,' Vol. I., pp. 376–429, particularly page 397.

ADDENDUM.—MAY, 1898.

Since this lecture was delivered I have received from Professor Roberts-Austen the following results of experiments on the melting-points of rocks which he has kindly made at my request:

	Melting-point.	Error.
Felspar.....	1520° C.	±30°
Hornblende.....	about 1400°	
Mica.....	1440°	±30°
Quartz.....	1775°	±15°
Basalt.....	about 880°	

These results are in conformity with what I have said in §§ 26–28 on the probable origin of granite and basalt, as they show that basalt melts at a much lower temperature than felspar, hornblende, mica or quartz, the crystalline ingredients of granite. In the electrolytic process for producing aluminium, now practiced by the British Aluminium Company at their Foyers works, alumina, of which the melting-point is certainly above 1700° C. or 1800° C., is dissolved in a bath of melted cryolite at a temperature of about 800° C. So we may imagine melted basalt to be a solvent for felspar, hornblende, mica and quartz at temperatures much below their own separate melting-points; and we can understand how the basaltic rocks of the earth may have resulted from the solidification of the mother liquor from which the crystalline ingredients of granite have been deposited.

KELVIN.

MENTAL FATIGUE.

THE purpose of this article is to give a preliminary report of some experiments on mental fatigue made by the writer. It is expected that they will later be presented in detail, and accordingly only the method and theoretical conclusions will be now stated.

Mental fatigue may mean either the fact of incompetency to do certain mental work or a feeling of incompetency which parallels the fact or the feeling or feelings denoted by our common expressions 'mentally tired,' 'mentally exhausted.' Among the conclusions to which the experiments have led are the following: first, that the fact of incompetency is not what it has been supposed to be; second, that there is no pure feeling of incompetency which parallels it and is its sign, that consequently the mental states ordinarily designated by the phrases mentioned are not states made up of such a feeling of incompetency, but are very complex affairs; and third, that these mental states are in no sense parallels or measures of the decrease in ability to do mental work.

We have been accustomed to think of mental work in terms of mechanics. The mind has been supposed to lose its power to work as a rubber ball loses its power to bound. As the ball rebounds to a lesser and lesser height so the mind has been supposed to think with less and less vigor. We have talked as if sleep charged the mind with mental energy as a current might charge a storage-battery with electricity and that then the mind had this stock to spend. As it spent it, it could exert less and less energy in its thinking. One could easily show the impropriety of such views by demonstrating the inconceivability that the complexity of mental action should fit so simple a scheme, but it is also useful to show the same thing by proof that in the case of certain people the mind does not lose its power to do work from having done large amounts of it. My experiments show in certain individuals no decrease in amount, speed or accuracy of work in the evenings of days of hard mental work over mornings or in periods immediately following prolonged mental work over periods preceding it.

So far as these and many other experiments go they all agree in denying that the cause for a decreased amount of mental work is such a simple lessening of some one factor, mental energy or whatever one cares to call it. They would affirm, on the contrary, that we did less work when tired, not because this stock of mental energy was running low, but because ideas of stopping, of 'taking it easy,' of working intermittently came in and were not inhibited; because feelings of boredom led to their consequences of leaning back in one's chair, looking at the clock, etc.; because a certain feeling of physical strain weakened one's impulse to read, write or translate; because sleepiness clouded our mental vision; because headaches or eye-aches tended naturally to inhibit the processes which caused them, etc., etc.

As to the pure feeling of incompetency I fail utterly to find it in myself or to get any intelligible account of it from others. After one separates out from the feelings of mental fatigue the factors just mentioned, especially the feelings of physical pain and strain, the feelings of mental nausea at certain ideas, and the feeling of sleepiness, I do not think that he will find anything left that is worth naming.

That the feelings of fatigue which we do have are not proportionate concomitants with the decreasing ability to do mental work is shown by the fact that all the persons in our experiments reported a large measure of such feelings in cases where their mental work was quite up to the average. In general a comparison of the introspective

records of feelings with the actual mental ability displayed shows that the former are not a parallel or measure of the latter.

The quantitative results obtained would seem to show that the degree of real inability caused by mental work was very much less than has been supposed; that in ordinary life nature warns us by the complex feelings mentioned not to work mentally some time before we are really incapacitated for work. They would also suggest that the results which those investigators who have sought to measure mental fatigue in school children have obtained were due to the use of methods which did not measure the *inability*, but the *distaste* for mental work, of the children. One is tempted to put forth the paradox that real mental incompetency is the rarest of all reasons for stopping or decreasing mental effort.

The methods used to estimate the ability to do mental work are to some extent new and so worth mention. The chief was the mental multiplication of three figures by three (*e. g.*, 794 x 683); of two figures by three, and in some cases four by four. This work, at least for the subjects of these experiments, required the utmost concentration. It is very fatiguing (in the ordinary sense of the word). Any interruption or distracting influence is felt at once and makes successful work impossible. So one would suppose that it ought to show the influence of decreasing power to do mental work as clearly as could anything. The amount of work and the mistakes can be easily and accurately recorded.

Another method involved the addition of columns of twenty numbers, each of five figures. This does not require close concentration, but the work done should show perfectly the fact of mental fatigue in so far as that involves the accuracy and speed of associations between ideas. The speed and accuracy of discrimination of the lengths of lines and of the perception of letters were also used. The tests were arranged so as to eliminate the effects of practice.

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SCIENTIFIC BOOKS.

The Development of English Thought: A Study in the Economic Interpretation of History. By SIMON N. PATTEN, PH.D., Professor of Political Economy, Wharton School of Finance and Economy, University of Pennsylvania. New York, The Macmillan Co. 1899. Pp. xxvii + 415.

"We don't know him; let's heave half a brick at him." The process is simple, obvious and, to the heavers, effective. There are only too many grounds for the fear that Professor Patten's new work will be treated as a vile body for this old experiment. Everyone knows how easy it is to discredit generalization by advancing negative instances; how sweet to cavil at principles by alleging that facts have been twisted to fit; how seductive to emphasize the specialist's standpoint and to magnify its abounding limitations. I do not exaggerate in saying that it is long since I have encountered a book which lies so open, so invitingly open, to these insidious attacks; or, on the contrary, one which proves so conclusively the unfairness, superficiality, even stupidity, of such criticism. For Professor Patten sets theory in the forefront of his discussion, and the body of his work sees the persistent application of this theory. Nevertheless, he who runs may read that, in the author's mind, the theory came last, being the inference from his detailed investigations, the final form in which the multitudinous facts shaped themselves—ceased to be mere isolated phenomena and became rationally one.

Professor Patten's theory reposes on a quasi-psychological basis. Sensory ideas, or ideas brought by the senses from the environment, constitute the material of knowledge; and "sensory knowledge is merely the amplification and classification of the differences perceived by the senses." (2) Such processes produce series of mental images; these, in turn, occasion relative motor reactions. Consequently a "man's

activities are determined by that part of his ideas for which motor reactions have been provided." (3) These complicated results are, of course, affected profoundly by differences of environment. In 'local' environments motor reactions predominate, in 'general' environments sensory ideas. Thus, 'stratification of society' does not take place in obedience to such 'superficial' causes as wealth and social position, but must be referred to 'psychic' characteristics. "A race ideal differs from its elements or from an abstract concept by having a motor reaction united with it (173). * * * Before the time of Locke there were three types of Englishmen —the Puritan, the clinger and the sensualist. Locke's analysis had split the Puritan party into two parts. One section was transformed into stalwarts, who placed race ideals above reason and sense impressions, and the other into mugwumps, who made the opposite choice" (185). Viewed in this light, English society has consisted of four great classes—'Clingers, Sensualists, Stalwarts, Mugwumps' (23–32). 'Clingers' spring from 'local' environments; 'Sensualists' appear when environments become richer in objects; they break down local traditions and stand forth as conquerors. When society becomes sufficiently differentiated, 'Stalwarts' are evolved—men who love creeds and react from sensualism to asceticism. Finally, increased wealth produces 'Mugwumps,' who evince a highly developed sensory side, and so are strong in thought, but weak in action. "Its members are cosmopolitan in their sympathies; advocates of compromise and policy in politics; sceptical in thought, and agnostic in belief. They dislike ideals, creeds and utopias, and are ever ready to expose shams and cant in which other people disguise their sentiments" (31). The history of English thought is the history of the appearance, interaction and transformation of those classes. "The sensualist is the original unmodified Englishman, who retains the dross of primitive times. The clinger is the result of qualities grafted on English nature by the supremacy of the Church. The stalwart is the concrete Puritan. The conflict was a three-cornered fight in which either the sensualist or the Puritan was the aggressor, while the clinger joined in with the defensive party (139). * * * The three-cornered fight had to go on until some solution could be found other than those these parties could offer. A new type of man was demanded, a type endowed with mental qualities different from those Englishmen then possessed" (141–2). If the matter be treated in this way one is freed from foreign methods of interpretation and gets to know English character as it actually was and is, in its own peculiar nature (cf. 43). It ought to be said that our author himself recognizes the limitations of this standpoint and not merely on his title-page. "Economic conditions create the primary motor reactions, put them to new uses and give them a form quite different from that they have at the outset. * * * The consequence is that a motor reaction, after losing its primal economic importance, responds to abstract instead of concrete phenomena" (50–1). Further, it ought to be added that the most interesting, and, as I believe, the most effective part of the work is the second half, where this limitation does not press so heavily. The execution of this portion, which deals with English thought as ruled by the 'Mugwump,' is a most important contribution to the subject, one that all English philosophers, especially those who see no good thing outside of Germany, would do very well to mark, learn and inwardly digest. "If we view English thought from this standpoint there are three clearly defined epochs. In the first Hobbes states the problem without solving it; Locke is the economist on the upward curve; Newton is the thinker on the downward curve. In the second Mandeville states the problem; Hume is changed from an economist into a philosopher, and Adam Smith from a philosopher into an economist. The third epoch, beginning with Malthus, ends when Mill is transformed into a philosopher and Darwin into a biologist" (55).

Taking the book as a whole, no one can fail to be impressed with its freshness, originality and great brilliance in some places. While the style is plain and straightforward for the most part, incisive sayings—almost epigrammatic on occasions—attract attention or serve to stimulate rapid thought. Indeed, sometimes Professor Patten contrives to cast a flood of light

over an entire period by their use. I had marked a large number of penetrating purviews and new reflections for quotation, but limits of space forbid more than briefest reference to a very few. The theory of curves of thought (43); the value of monastic influences (71); the contrasts between communal and family life (81, 192, etc.); the relation of Catholicism and Protestantism to vice and crime (94); the misfortunes of the Reformation (104); the suddenness of English civilization (126); Locke's office (162); the meaning of Deism (175); the contrast between England and France (187, 281); the presentations of Wesley and Whitefield (250); the 'origins' of Adam Smith (264); the criticism of current sociology (333); Romanticism and religion (353)—all serve to illustrate the originality and one might almost say weird suggestiveness of Professor Patten's inferences, and other instances might be adduced indefinitely.

On the other hand, a few things give one pause. To begin with, Professor Patten will perhaps not take it amiss if a Scot informs him that Scottish thought is not a variant of English. Hume and Adam Smith and the Mills would not have been what they were had their nationality lain south of the Tweed. At the same time, I am well aware how difficult it is for the foreigner to understand that the Cheviots divide, if not two civilizations, then two ways of thinking. The doctrine of the 'manly man,' the 'womanly man,' and so forth (255, 318, 341, etc.), seems a little far-fetched to be made so much of; perhaps it applies in the case of John Stuart Mill. The bath theory (192) of English civilization; the treatment of Calvinism (110, etc.); the contrast between Cavalier and Puritan (119); the gulf between the upper and lower classes in England (130); the emphasis upon clothing (191); the passage from a liquor to a sugar diet (381)—all seem to me to be somewhat fanciful or, at least, to be used in support of conclusions which do not necessarily connect with them. Many of the 'Concluding Remarks' are vitiated by the author's foreign standpoint. For example, the identification of religion and economics, while strikingly true of the United States, is incomparably less true of England, and must remain so till the Anglican Church loses its endowments. I ought to add that some of these objections would probably appear less forcible to one fully informed on economic questions.

Finally, the appreciations of English philosophical thought are wholly admirable. The value of the new lights cast on Locke (158), Mandeville, Hume (215, 223), the Mills, especially the son (331), Darwin (345), and the present position of English philosophy (377) and religion (398), cannot be overestimated at the contemporary juncture. Emphasis ought to be laid on the masterly discussions of Ricardo and Adam Smith; the interpretation of the former is most illuminating.

So far as I am capable of judging, the book is obviously the work of a very able man and one unusually well informed; of a man who has extraordinary capacity for seeing and telling truths pointedly, even though he may miss the whole truth time and again. In any case, it must be reckoned with and cannot miss the exercise of wide influence, whether this be of a negative or positive character.

R. M. WENLEY.

UNIVERSITY OF MICHIGAN.

Peruvian Meteorology, 1888–1890. Compiled and prepared for publication by SOLON I. BAILEY, under the direction of EDWARD C. PICKERING. Annals of the Astronomical Observatory of Harvard College, Vol. XXXIX., Part I. 4to. Cambridge, Published by the Observatory. 1899. Pp. 153. Pls. VI.

It is safe to say that no publication has been awaited with greater interest among meteorologists than the volume now before us. Ever since the establishment of the permanent Southern Station of the Harvard College Observatory at Arequipa, in 1891, and of the auxiliary meteorological stations in connection with it, every meteorologist the world over has been anxious to have access to the data which have been gathered concerning the climatic conditions of that unique region. The notable discoveries made on the photographic plates from Arequipa have turned the attention of every astronomer towards Peru. Now the meteorological world likewise turns towards Peru in the study of the records which are for the first time accessible. Readers of SCIENCE will remember that the

astronomical and meteorological work of the Observatory of Harvard College in Peru is the result of a bequest left to the Observatory in the will of Mr. Uriah A. Boyden, in 1887. Under the terms of the will this money was to aid in the establishment of an observatory "at such an elevation as to be free, so far as practicable, from the impediments to accurate observation which occur in observatories now existing, owing to atmospheric influences." It was in connection with the study of the atmospheric conditions of the desert strip of the west coast of South America, with a view to determining the best possible site for the new observatory, that the early meteorological observations in Peru were undertaken. The stations selected for the taking of these preliminary observations were Mollendo, Arequipa, Vincocaya, Puno and Chosica. The first four stations are between latitude S. 15° 40′ and S. 17° 5′, on the *Ferrocarril del Sur del Peru*, which runs from Mollendo, on the sea coast, northeast to Puno, on Lake Titicaca, a distance of 325 miles (by rail). Mollendo is immediately on the coast (altitude 80 feet). Arequipa is at a distance of 80 miles in a direct line from the Pacific Ocean, at an altitude of 7,550 feet. Vincocaya is 14,360 feet above sea level, on a desolate plateau, near the crest of the Western Cordillera. Puno (12,540 feet) is on the western shore of Lake Titicaca. The station at Chosica was situated about 25 miles northeast of Lima (altitude 6,600 feet). A few observations, chiefly of cloudiness, were made at the Pampa Central, near the central western part of the Desert of Atacama, in Chile.

These early observations were made during the years 1888–1890, with more or less completeness. They are, however, preliminary. They were almost all made by observers who had had little or no experience and who received no compensation for their services. The instrumental equipment in use at the different stations varied considerably; the hours of observation were not always the same; the location of the instruments was sometimes changed. In short, the work as a whole was done in an unsystematic and incomplete and often in a very inaccurate way. This was, of course, absolutely unavoidable. It was impossible to secure trained observers, to inspect the stations, or to test the instruments. The observations were, therefore, liable to be considerably in error. Thus, in connection with the minimum thermometer readings at Chosica the statement is made in a note that it is probable that the lower end of the index in the minimum thermometer was read, instead of the upper end. And in the wind observations at Arequipa and Vincocaya it is noted that "the direction of the wind was always given, even if the remark appended was 'calm' or 'dead calm.' Apparently the position of the wind-vane was recorded, whether at the time wind was observed or not." These two cases will serve to indicate the sort of errors which inevitably appear in these records. We do not intend to criticise adversely the publication of these early Peruvian observations, but merely to point out their necessary inaccuracies. Professor Pickering says very clearly in the preface: "These observations must not be regarded as indicating the accuracy of those made later. * * * It must be remembered that it was not possible under the conditions then existing to obtain observations of the accuracy of those made by professional observers at permanent and easily accessible observatories." And again, on page 68, Professor Bailey says: "The results are perhaps as reliable as are possible in such outlying stations, where experienced observers cannot be obtained and frequent supervision is impossible."

The published observations comprise twenty-nine tables. The data are by no means equally complete for all stations. At Mollendo, Arequipa and Vincocaya the instruments in use were the maximum, minimum and ordinary thermometers, thermograph and rain-gauge. At Arequipa a solar radiation and a wet-bulb thermometer were also used. At Puno the observations were continued but a short time, and there was no thermograph. At the Chosica station, in addition to the above-named instruments, there were a barograph, sunshine and pole-star recorder. At Pampa Central cloud observations only were made, four times daily. There are several tables showing the hourly means of the barograph and thermograph, and a comparison of thermometer and thermograph hourly and monthly means. Curves are also

given showing the diurnal variation of temperature at Mollendo, Arequipa, Vincocaya and the Chosica station; the diurnal variation of pressure for the Chosica station, and the annual range of the afternoon oscillation of pressure at the Chosica station. Beyond some general remarks in explanation of the tables, there is no discussion of the observations.

Besides the meteorological portion proper, this volume contains a very attractive account, by Professor Bailey, with some excellent illustrations, of the volcano El Misti (19,200 feet), and of the establishment of the now famous Misti meteorological station on its summit. There is also a carefully compiled account of *The Configuration and Heights of the Andes*, which will be of distinct value to geographers.

We presume that Professor Pickering may receive some rather severe criticism in certain quarters for the publication of meteorological data which are so incomplete and which, doubtless, have very many inaccuracies. But we agree with him in believing that, considering the interest of the region in which these observations were made, and the lack of information concerning its meteorology, such results deserve publication, provided careful statement is made in regard to the circumstances under which the data were collected. Professor Pickering and Professor Bailey have both made these conditions perfectly clear, and we believe that the results, when viewed in the light of these statements, will prove not only of great interest, but also of great value.

R. DEC. WARD.

The Elements of Physical Chemistry. By J. LIVINGSTON R. MORGAN, PH.D., of the Department of Physical Chemistry, Columbia University. First edition, first thousand. New York, John Wiley & Sons; London, Chapman & Hall, Limited. 1899. Pp. 299.

This little book deals with the gaseous state, the liquid state, the solid state, solution, the rôle of the ions in analytical chemistry, thermochemistry, chemical change, including equilibrium and chemical kinetics, phases and electrochemistry.

The aim of the author is to present the elements of physical chemistry in brief form to those who do not have the time or opportunity to go more extensively into the subject. An examination of the work will bring out much that is of interest and importance, and a careful study of it will help a beginner to obtain an insight into the subject. But the objection might be raised to the work as a whole that it seems to deal rather with conclusions and generalizations than with the evidence upon which such are based. Further, there are many omissions which it is difficult to account for. Thus, under liquids no mention is made of Kopp's work on atomic volumes; of the work of Pulfrich, Landolt, Gladstone, Brühl and others, on the refractivity of liquids; of the rotation of the plane of polarized light and the Le Bel-Van't Hoff hypothesis; of the work of Perkins, and of Rodger and Watson on magnetic rotation; of Thorpe and Rodger on viscosity; of Ramsay and Shields on the surface-tension of liquids as applied to the determination of molecular weights. It would seem that such important work as the above ought to be referred to briefly even in an elementary treatise designed to cover the whole field of physical chemistry. An examination of the book will show, further that much of the more recent experimental work has not been taken into account, indicating that text-books which have been published several years, rather than the original literature, have been drawn upon as the source of material. As in most text-books, so here, an occasional statement is not quite accurate. But what book is perfectly logical, thoroughly comprehensive and rigidly exact throughout?

HARRY C. JONES.

BOOKS RECEIVED.

The Anatomy of the Central Nervous System of Man and of Vertebrates in General. LUDWIG EDINGER. Translated from the fifth German edition by WINFIELD S. HALL, assisted by P. L. HOLLAND and E. P. CARLTON. Philadelphia, F. A. Davis Company. 1899. Pp. xi + 446.

Marriages of the Deaf in America. EDWARD ALLEN FAY. Washington, Gibson Bros. 1898. Pp. vii + 527.

A Century of Vaccination. W. SCOTT TEBB. London, Swan, Sonnenschein & Co. 1899. Second Edition. Pp. 452.

Essai critique sur l'hypothèse des atomes dans la science contemporaine. Arthur Hannequin. Paris, Alcan. 1899. Second Edition. Pp. 457.

Social Phases of Education in the School and the Home. Samuel T. Dutton. New York and London, The Macmillan Company. 1899. Pp. viii + 259.

The Fur Seals and Fur Seal Islands of the North Pacific Ocean. David Starr Jordan. Washington, Government Printing Office. 1898. Pp. 606 and 13 Plates.

SCIENTIFIC JOURNALS AND ARTICLES.

American Chemical Journal, May. The Action of Metals on Nitric Acid: By P. C. Freer and G. O. Higsley. The reduction of strong acid is due to the metals alone, but with dilute acid both metal and hydrogen take part in the reduction. On the Dissociation of Phosphorus Pentabromide in Solution in Organic Solvents: By J. H. Kastle and W. A. Beatty. On the Color of Compounds of Bromine and of Iodine: By J. H. Kastle. The explanation offered is that the color is due to a slight dissociation of the solid substance. On the Formation of Potassiums B-ferricyanide through the action of Acids on the Normal Ferricyanide: By J. Locke and G. H. Edwards. A very small amount of acid is sufficient to produce this change without the presence of any oxidizing agent. Trinitrophenylmalonic Ester: By C. L. Jackson and J. I. Phinney. The Relation of Trivalent to Pentavalent Nitrogen: By A. Lachman. The authors report the results so far obtained in an attempt to establish the trivalent or pentavalent condition of nitrogen, in various compounds, by the action with zinc ethyl.

J. Elliott Gilpin.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES—SECTION OF BIOLOGY, MARCH 14, 1899.

Observations on the Germ Layers of Teleost Fishes: F. B. Sumner.

Mr. Sumner showed that Teleost eggs can be divided into two types according to their approach to the holoblastic form of cleavage; that germ disc and yolk cannot strictly be contrasted as epiblast and hypoblast respectively; that the germ-ring arises either by involution or delamination or both; that the 'prostoma' of Kupffer is a reality. Kupffer's contention that the prostoma represents the entire blastopore is, however, wrong. Mr. Sumner showed also that the hypoblast in the stone-catfish is derived partly from the posterior lip of the prostoma and partly from the germ-ring; perhaps wholly from the prostoma in the trout; that the function of Kupffer's vesicle, which arises as a cleft between the prostomal entoderm and the involuted margin of the blastoderm, is probably the absorption of fluid nutriment elaborated from the yolk by the periblast.

Further Notes on the Echinoderms of Bermuda: H. L. Clark. Presented by Professor C. L. Bristol.

Dr. Clark's paper sums up the work on the Echinoderms collected by the New York University Expedition in the summers of '97 and '98, and presents a check list of the Echinoderms thus far reported from Bermuda. The collection of 1898 was especially rich in holothurians, containing many species hitherto collected, adding several others to the list from Bermuda, and one new to science. From his work on *Stichopus* Dr. Clark suggests that the different forms found in Bermuda may be mature and immature individuals of *S. möbii* (Semp.). *Synapta vivipara* was found under conditions widely different from those in Jamaica. The new *Synapta* is allied to *S. inhærens*, and Dr. Clark has named it *S. acanthia*.

The Echinoderms from Bermuda are distributed as follows: Asteroidea, 4; Ophiuroidea, 7; Echinoidea, 8; Holothuroidea, 10.

The Sequence of Moults and Plumages of the Passerine Birds of New York State: Jonathan Dwight, M. D.

Dr. Dwight fully described the process of moulting and its relation to the plumage of about one hundred and fifty species of land birds common to eastern North America. The early plumage of these birds was described, together with the time and method of the acquisition of later plumages. Stress was laid upon the underlying principles of the sequence or succession of plumages peculiar to each species, and the moults and plumages were classified according to a definite scheme by the author.

Gary N. Calkins,
Secretary.

SECTION OF GEOLOGY AND MINERALOGY, APRIL 17, 1899.

PROFESSOR J. J. STEVENSON in the Chair.

Dr. A. A. Julien presented a 'Note on a Feldspar from the Calumet Copper Mine, Keweenaw Point, Michigan,' with specimens collected by him at the first opening of that mine. The wide distribution of the mineral was pointed out, through both the Portage Lake and Ontonagon districts, as drusy linings of cavities in the amygdaloid and in crystals scattered through the cement of the copper conglomerate. The crystals were of simple type, a rhombic prism with orthodome modification on obtuse angles, but both faces and cleavage-planes were often distinctly curved. By the complete analysis presented, it was identified as a normal orthoclase, with an unusually large proportion of protoxides in isomorphous replacement. These seemed to bear a relationship to the instability of the mineral, indicated by its general partial decomposition; to its remarkably low Specific Gravity, 2.455; and possibly, in part, to the curvature of its planes.

Professor J. F. Kemp called attention to the unusual presence of cobalt oxide in a feldspar, shown in the analysis.

Dr. E. O. Hovey then gave a very interesting description, with lantern illustrations, of 'Geological and Mineralogical Notes Gathered during a Collecting Trip in Russia,' in connection with the excursions of the recent International Congress. Many of the lantern pictures were beautifully colored; they referred in part to ethnographic observations; and the accompanying remarks awakened much interest.

ALEXIS A. JULIEN,
Secretary of Section.

GEOLOGICAL CONFERENCE AND STUDENTS' CLUB OF HARVARD UNIVERSITY.

Students' Geological Club, March 28.—Mr. C. H. White explained a method of field work that has been developed by the members of the Appalachian Division of the United States Geological Survey. It can be used only in regions of distinctly bedded rocks of low dip, and has the merit of greatly facilitating both field and laboratory work. Mr. A. W. Grabau exhibited a number of new paleontological specimens which were collected by Mr. W. W. Dodge from the middle Cambrian, at Braintree, Mass. These included nine very perfect specimens of a new species of Acrothele.

Geological Conference, April 4, 1899.—In 'A Comparison of Snow-chart with Ice-lobes,' Mr. R. R. Kent described a method of comparing the location of snow accumulations of the present time with those of glacial time; the position of the former being indicated by snow-charts and the latter by frontal moraines. From these snow-charts, issued weekly by the Weather Bureau, composite charts for the winters of '96–'97 and '98–'99 were constructed. These showed that the lines of equal snow-averages follow lobations which in character and position closely correspond to the glacial lobes. The driftless area of Wisconsin was thus shown to have been an area of minimum snow-average, during the past winter. In their tendency toward local retention, the distributions of snow for these two winters show in miniature a remarkable likeness to the supposed distribution of glacial times.

In considering the causes of annual isochional lobations, maps were shown which gave lines indicating equal frequency of exposure of local areas to traversal by cyclonic areas during these winters. These present a remarkable resemblance between these lines and the distribution of snow. Accordingly, the speaker concluded that the lobations shown by the charted averages are due to meteorological rather than to topographical causes.

Dr. R. A. Daly communicated the results of a study of etch figures produced with hydrofluoric acid and the caustic alkalies on the principal planes of the amphiboles, with especial reference to the cleavage prism. He summarizes the chief problems which he studied in this connection as follows: "(1) The orientation of the amphiboles—that of Tschermak (Dana, Lacroix) is preferred to that of Nordenskiöld (Hintze); (2) the orientation of cleavage pieces of amphiboles; (3) the limits of variation on (110), (010) and (100) of the different species of amphibole—these can be used for determinative purposes; (4) the testing of Retgers' law that isomorphous bodies must have, using the

same reagent, similar etch figures on the same face—it is concluded that, if the law hold actinolite and all amphiboles without a sesquioxide, cannot be isomorphous, with a hornblende; (5) the holohedral character of all amphiboles—it is established for monoclinic and orthorombic species; (6) the demonstration of the orthorombic character of anthophyllite and of gedrite, a doubt of which has been expressed by Hintze and others; (7) a comparison between the amphiboles and pyroxenes as to etching properties—an extraordinary likeness in the figures produced on the pinacoids and on the artificial face of actinolite representing in position the plane (110) of diopside seems to ally the two groups even more closely than has been suspected; (8) the proof that close attention must be given to the *method* of etching with hydrofluoric acid."

The discovery of anomalous etch-pits on a hornblende from Philipstad, Sweden, led to the recognition of a new variety of hornblende characterized by a well-marked zonal structure, an unusually small optical angle, an unusual pleochroism and absorption scheme, and a peculiar chemical composition. For details see Proceedings of the American Academy of Arts and Sciences, Vol. XXXIV., Nos. 15 and 16, March, 1899.

J. M. Boutwell,
Recording Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis of May 1, 1899, nineteen persons present, the Secretary presented by title a paper by Professor F. E. Nipher, on gravitation in gaseous nebulæ.

Dr. Amand Ravold exhibited cultures and microscopic specimens showing the *Micrococcus intercellularis meningitidis* of Weichselbaum, obtained from a case of cerebro-spinal meningitis, and stated that this case afforded an interesting instance of germ infection through the placenta, inasmuch as the cerebro-spinal system of an unborn child of the patient was likewise found to be infected by the germ, from which source, in fact, the specimens exhibited were derived.

Mr. H. von Schrenk presented the general results of a study of certain diseases of the yellow pine, illustrating his remarks by the exhibition of a number of specimens showing the characteristic phenomena of the diseases and the fruiting bodies of the fungi which cause them.

William Trelease,
General Secretary.

UNIVERSITY OF COLORADO SCIENTIFIC SOCIETY.

The following papers have been presented during the year: 'Methods of determining the Solar Parallax,' Dr. Frederick L. Chase, of Yale University; 'A Theory of the Nature of Philosophy, Dr. Francis Kennedy; 'The Velocity of Electrical Waves,' Dr. Wm. Duane; 'Graphical Methods of determining Stresses in framed Structures,' Mr. Frederick T. Rubidge; 'Wireless Telegraphy,' Dr. Wm. Duane.

The Society meets the first Friday in each month from November to March. All men of science are invited to attend the meetings.

Francis Ramaley,
Secretary.

Boulder, Colo., April 28, 1899.

DISCUSSION AND CORRESPONDENCE.

THE STORAGE OF PAMPHLETS.

Recent correspondence on this subject in the pages of Science suggests that a description of the method adopted in my private library, as also in that of the Geological Department of the British Museum, may interest some of your readers.

The pamphlet-box finally evolved after some years of experiment is constructed thus: a solid back of wood (*a*), to each side of which is hinged (at *h*) a half-box (*b*). When closed, one half slightly overlaps the other by a rebated edge, so as to exclude dust; they may be fastened by a catch, but this is quite unnecessary in the smaller and lighter makes. When open both sides and back lie flat on the table; or, if space be limited, one side can hang down over the edge of the table or can be kept standing up. In the lighter makes the sides are of pasteboard, and are hinged to the back by a linen hinge (*h*), the outside is all covered with stout binder's cloth and the inside is lined with white glazed paper. In the heavier makes (suitable for large quartos or for a public library) the

sides are of thin wood, similarly hinged to the back, but on the outside the back and the hinges are covered with roan. Attached to the inner side of the tail end of the back is a loop of tape or roan, by which the box can be pulled out from the shelf. The outside measurements of the size adopted in my library for ordinary pamphlets are, height, 11½ inches; depth, 9 inches; thickness, 3¾ inches. The thickness of the material is from ⅛ to ¼ inch according to its position.

The merits of this type of case are extreme simplicity, readiness of access to pamphlets, freedom from dog-earing the corners or folding the wrappers as pamphlets are taken in and out. To refer to a pamphlet one simply places the back of the case on the table, lets fall the two sides on to the table and turns over the pamphlets until the desired one is found. Without

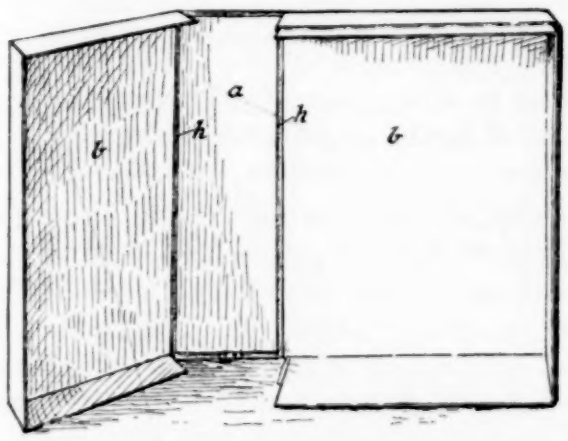

FIG. 1. The pamphlet-case open and seen from the inside.

removing the pamphlet one can turn over the pages, note the passage required and then without further ado close the sides of the pamphlet-box just as one would close a bound book, and replace it on the shelf. The cases are light, dust-proof and durable; and the lighter ones cost me 2s. 9d. (66 cents) apiece when ordered by the half gross.

As for arrangement, each worker will follow the method that suits him best. I sort the pamphlets first into subjects, and within each subject arrange them alphabetically under authors' names; those of each author are placed chronologically. Any number of boxes may go to one subject. Each is labelled on the back with a white paper label on which the subject is stencilled in black, while the letters contained in that particular box are marked in broad soft pencil, easily changed as required (see Fig. 2).

FIG. 2. The pamphlet-case closed as it stands on the shelf.

In this way the boxes devoted to Crinoidea have grown from 1 to 14 and the position of no pamphlet has ever been in doubt.

Of course a card-catalogue is a necessary adjunct to a collection of any size, as it enables one to assign a doubtful pamphlet to any subject, and to find it again by a symbol pencilled on the catalogue slip.

It may be paternal prejudice, but I certainly consider this form of case simpler and more effective than any I have seen or read about. I do not say that it is cheaper.

F. A. BATHER.

THE MARINE BIOLOGICAL LABORATORY AT WOOD'S HOLL.

'THE ANNUAL ANNOUNCEMENT OF THE MARINE BIOLOGICAL LABORATORY.'*

THE Twelfth Session of the Marine Biological Laboratory will begin on June 1st, and will continue for four months. This session promises to be the most successful in the history of the Laboratory. While the courses of instruction heretofore offered will be maintained by an exceptionally strong staff, three entirely new courses have been added, these courses in

*Copies of the Announcement may be had on application to the Director, Professor C. O. Whitman, University of Chicago, or to the Assistant Director, Professor Ulric Dahlgren, Princeton University.

(Cytology, Physiology and Psychology) being under the immediate supervision of men eminently fitted for their work.

The course in Cytological Research will be conducted by Professor Watasé, with the assistance of Mr. W. H. Packard. The course is designed for a limited number of students who are prepared to begin investigation. A special problem will be assigned to each member of the class, and methods of dealing with it will be suggested. The laboratory work will be accompanied by a series of lectures on general cytological subjects, designed to give a view of the field of cellular biology as a whole, and at the same time to indicate the bearings of the problems under investigation.

The course in General and Comparative Physiology will be conducted by Dr. Loeb, assisted by Drs. Norman, Lyon and Mathews, and will consist of laboratory work and lectures. The following is a brief outline of the work:

I. The Tropisms of Animals. Galvanotropism, Heliotropism, Geotropism and Compensatory Motions, Chemotropism, Heterotropism in sessile and free forms.

II. Effects of External Influences upon Living Matter (lack of oxygen, acids and alkalies, temperature, etc.).

III. Physiological Morphology. Experiments on Growth and Development, Regeneration and Heteromorphosis.

IV. Comparative Physiology of the Central Nervous System and Comparative Psychology.

V. Comparative Physiology of Digestion.

VI. Comparative Physiology of Secretion.

VII. Micro-chemistry.

In Comparative Psychology, Dr. Edward Thorndike will give a course of lectures on the Sense-powers, Instincts, Habits and Intelligence of Animals, and will direct the work of a few students in this department.

Opportunities for work in Botany are especially inviting. Drs. Davis and Moore, as heads of the department, will have general charge of the laboratory.

The course of lectures in Plant Morphology and Physiology is supplied by such a strong corps, and the subjects are of such scientific importance, that we copy the program in full:

A COURSE OF LECTURES ON PLANT MORPHOLOGY AND PHYSIOLOGY.

First Week, July 5–12.—Erwin F. Smith, 'Bacteria'; D. T. MacDougal, 'Physiological Subjects'; Douglas H. Campbell, 'The Evolution of the Sporophyte in the Archegoniates and Flowering Plants.'

Second Week, July 12–19.—Miss Clara E. Cummings, 'Lichens'; L. M. Underwood, 'The Evolution of the Hepaticæ'; Rodney H. True, 'Plants and Poisons.'

Third Week, July 19–26.—H. J. Webber, 'Spermatogenesis, Development of Embryo Sac, and Fecundation in Gymnosperms'; C. O. Townsend, 'Physiology of the Plant Cell.'

Fourth Week, July 26–August 2.—J. M. Macfarlane, 'Plant Irritability'; G. F. Atkinson, 'Higher Fungi.'

Fifth Week, August 2–9.—J. M. Macfarlane, 'Physio-morphology of a Few Angiospermic Orders'; Henry Kraemer, 'The Unorganized Contents of the Cells of Plants.'

Sixth Week, August 9–16.—D. M. Mottier, 'Cytological Studies on the Pollen and Embryo-sac of Angiosperms'; D. P. Penhallow, 'Paleobotany.'

Within the last few years workers at Wood's Holl have derived great profit from the free discussion of various biological methods, facts and theories. During the coming summer there will be three seminars: The Neurological, Biological and Botanical—a series of lectures on Zoological Technique, and the customary course of 'Evening Lectures.' The latter are designed to present the results of research in different lines and departments, in so far as these are of general interest.

There are thirty names on the list of officers of instruction, and fifty-four names on the list of lecturers. In these two lists fully thirty-five educational institutions are represented.

GEOLOGICAL EXPEDITION OF DR. BECKER TO THE PHILIPPINES.

Dr. Geo. F. Becker, the expert economic geologist, who, early last summer, was sent by the Director of the U. S. Geological Survey, under a cooperative arrangement with the War Department, to Manila to make a reconnaissance of the geologic structure and mineral re-

sources of the Philippines, has been prevented by the uncertainty of the political situation and the state of war there existing from prosecuting these investigations, through no fault, however, of either Admiral Dewey or General Otis, both of whom would ere this have provided the facilities for safe travel about the islands, etc., if it had been possible to do so. From recent advices from the military authorities at Manila, however, it appears that, not content to rest in idleness, Dr. Becker early attached himself to the Bureau of Military Information of the Army, and soon became the right-hand man of Major J. F. Bell, in charge. Official reports and papers that have since passed between Major Bell and the Commanding General, and letters from the officers to Director Walcott, record numerous valuable services rendered by Dr. Becker to the army through the Bureau of Military Information, and also repeated acts of gallantry and soldierly usefulness in action, and accord him high praise for his conduct. He is repeatedly and strongly complimented by his military superiors, from Major Bell to Generals MacArthur and Otis. The reports, which cover events only to the middle of March, mention no fewer than 14 military reconnaissances and active engagements had with the forces, in all of which Dr. Becker took part.

It has not yet been determined by the Director of the Survey how long Dr. Becker shall remain in the Philippine Islands, but it is believed that he will be able to make some substantial progress with his geologic investigations before he is recalled. Being skilled in rapid field observation, he will be able to advance the work rapidly if once he gets at it. It is not improbable that he is even now doing stratigraphic geology in the Island of Negros, with a view to correlating its structure with that of Cebu. At least, he expressed the hope when he last wrote to Director Walcott, March 1st, of being able to do this in April and after that of going to Cebu and studying the coal deposits.

It is reported that Dr. Becker contemplates returning to America via the Suez Canal and of making a study en route of the great tin deposits at or near Singapore.

W. F. M.

MAY 5, 1899

CONVERSAZIONE OF THE ROYAL SOCIETY.

THE first Conversazione of the season was held by the Royal Society at Burlington House, on May 3d. The guests were received by the President, Lord Lister, and a large number of men of science was present. The following particulars concerning the exhibits, which were of a more strictly scientific character than usual, are taken from the London *Times:* Professor Arthur Thomson exhibited a model to illustrate how natural curliness of the hair is produced. An exhibit from the Marine Biological Association of Plymouth illustrated methods of feeding of marine animals by means of living and preserved examples. A series of selected animals from the neighborhood of Plymouth was shown, illustrating different methods practiced for securing food. The Association also showed charts illustrating the distribution of the fauna and bottom deposits near the 30-fathom line from the Eddystone grounds to Start Point. Dr. Francisco Moreno, who has done so much for the exploration of Patagonia, exhibited a portion of skin of an extinct ground-sloth from a cavern in southern Patagonia, which has been exciting great interest among naturalists. To Dr. Moreno was also due a fine plaster reproduction of the skeleton of *Toxodon platensis*, an extinct ungulate quadruped from the Pampa formation, province of Buenos Ayres, Argentina. Dr. Woodward's selection of zoological specimens from Christmas Island, Indian Ocean, collected by Mr. C. W. Andrews, was of special interest, containing, as it did, some remarkable forms of insects, birds, and even rats. Not less interesting was the varied collection of birds, insects, shells, etc., brought home by Dr. H. O. Forbes and Mr. Grant from Sokotra.

Dr. Manson and Surgeon-Major Ross showed microscopes beneath which were displayed specimens of mosquitoes, showing the development of the parasites of malaria in their tissues, and also of the same parasites assuming deadly dimensions in the human tissues.

Among other exhibits were the new element Victorium, of the Yttrium group, one of the latest results of Sir William Crookes's long continued researches in phosphorescent spectra; Mr. Saville-Kent's natural-color photographs

of various zoological and botanical subjects; Mr. Carus-Wilson's specimens of decomposed flints; Wehnelt's electrolytic contact breaker, which seems capable of producing extraordinary results; Mr. Everard im Thurn's beautiful water-color sketches of Guiana orchids; Mr. Shelford Bidwell's experiments demonstrating multiple vision; Mr. Joseph Goold's intersection patterns in compound-vibration curves; Sir Norman Lockyer's photographs of stellar spectra, and a very delicate and threadlike photograph of a meteor taken by Mr. C. P. Butler on the night of April 8, 1899.

Among the new instruments which specially attracted attention was the radiation recorder of Professor H. L. Callendar, so delicate that it shows when the slightest haze passes across the sky. The microscopic specimens illustrating the further researches which have been made into the effects of strain in metals by Professor Ewing and Mr. W. Rosenhain are noteworthy. Mr. A. Mallock's ingenious adaptation of thin films of pyroxyline for use as mirrors deserves mention, as do also Mr. H. N. Dickson's series of charts illustrative of temperature and salinity in the North Atlantic. The lantern exhibitions were particularly attractive, especially Mr. Kearton's slides illustrating the haunts and habits of British birds. Dr. Sorby also used the lantern to show some beautiful slides of Actiniæ and other marine animals, and Mr. W. Duddell, oscillographs, applied to alternate current waveforms, and to the Wehnelt interrupter.

SCIENTIFIC NOTES AND NEWS.

The next meeting of the American Society of Naturalists will be held at New Haven, Conn., during Christmas week. Most of the 'affiliated societies' have signified their intention of meeting at the same place.

At the annual meeting of the American Academy of Art and Sciences, held May 10, 1899, the Rumford medal was, on the recommendation of the Rumford Committee, awarded to Mr. Charles F. Brush, of Cleveland, for 'the Practical Development of Electrical Arc Lighting.'

Professor C. F. Chandler, of Columbia University, has received the regular nomination for President of the Society of Chemical Industry. The election takes place in July at the annual meeting. This Society numbers 3,200 chemists, of whom nearly 600 reside in the United States. Its headquarters are in London; it has sections also in Liverpool, Newcastle, Nottingham, Glasgow, Leeds, Manchester and New York. In the list of former Presidents appear the names of Sir Henry E. Roscoe, Sir Frederick Abell, Walter Welden, W. H. Perkin, E. K. Muspratt, David Howard, Professor James Dewar, Ludwig Mond, Sir Lowthian Bell, E. Rider Cook, J. Emerson Reynolds, Sir John Evans, E. C. C. Stanford, T. E. Thorpe, Thomas Tyrer, Dr. Edward Schunck, F. Clowes and George Beilby.

Cambridge University has conferred the honorary degree of Doctor of Science on Sir William Turner, professor of anatomy of the University of Edinburgh, and on the Rev. Thomas Wiltshire, emeritus professor of geology in King's college, London.

At the annual meeting of the American Academy of Arts and Sciences on May 10, 1899, the following officers were elected: *President:* Alexander Agassiz; *Vice-President* for Class I.: John Trowbridge; *Vice-President* for Class II.: Alpheus Hyatt; *Vice-President* for Class III.: Augustus Lowell; *Corresponding Secretary:* Samuel H. Scudder; *Recording Secretary:* William Watson; *Treasurer:* Francis Blake; *Librarian:* A. Lawrence Rotch; *Member of the Committee of Finance:* Augustus Lowell; *Councillors* from Class I.: Henry Taber, Theodore W. Richards, Harry M. Goodwin; *Councillors* from Class II.: Benjamin L. Robinson, William T. Councilman, John E. Wolff; *Councillors* from Class III.: Barrett Wendell, Edward Robinson, James B. Ames; *Rumford Committee:* Erasmus D. Leavitt, Edward C. Pickering, Charles R. Cross, Amos E. Dolbear, Arthur G. Webster, Theodore W. Richards, Thomas C. Mendenhall; *C. M. Warren Committee:* Francis H. Storer, Charles L. Jackson, Samuel Cabot, Henry B. Hill, Leonard P. Kinnicut, Arthur M. Comey, Robert H. Richards.

The following 15 candidates have been selected by the Council of the Royal Society to be

recommended for election into the Society: Professor William F. Barrett, Mr. Charles Booth, D.Sc., Major David Bruce, A.M.S., Mr. Henry John Horstman Fenton, M.A., Mr. James Sykes Gamble, Professor Alfred Cort Haddon, Dr. Henry Head, Professor Conwy Lloyd Morgan, F.G.S., Mr. Clement Reid, F.G.S., Professor Henry Selby Hele Shaw, M.Inst.C.E., Dr. Ernest Henry Starling, Professor Henry William Lloyd Tanner, M.A., Mr. Richard Threlfall, Mr. Alfred E. Tutton, B.Sc., Professor Bertram Coghill Allen Windle, M.D.

DR. L. A. BAUER has resigned his position as assistant professor of mathematics and mathematical physics at the University of Cincinnati, in order to accept the position of Chief of the newly-formed Division of Terrestrial Magnetism, of the United States Coast and Geodetic Survey. To this Division has been assigned the magnetic survey of the United States and the countries under its jurisdiction and the establishment of magnetic observatories. Dr. Bauer has also been appointed lecturer in terrestrial magnetism at the Johns Hopkins University. The journal *Terrestrial Magnetism and Atmospheric Electricity*, beginning with the June number, will hereafter be issued from the Johns Hopkins University Press, Dr. Bauer continuing as editor-in-chief.

COMMISSIONER-GENERAL PECK has appointed Dr. Tarleton H. Bean Director of Forestry and Fisheries of the United States Commission to the Paris Exposition of 1900.

PROFESSOR EDGAR FRISBIE, of the U. S. Naval Observatory, having attained the age limit prescribed by the U. S. Navy, will retire on May 22d.

DR. G. LINDAU has been appointed Custodian of the Imperial Botanical Museum of Berlin.

Nature states that Mr. F. V. Bennett, who joined the Geological Survey of England in 1868, has resigned from the staff. During his long service he has mapped large areas of the Cretaceous, Tertiary and drift deposits in the eastern counties in Surrey, Berkshire and Wiltshire.

THE daily papers state that the gold medal of the American Geographical Society will be presented to Sir John Murray, the celebrated naturalist, on the occasion of the annual meeting of the Royal Geographical Society in June. The presentation will be made by United States Ambassador Choate.

THE Council of the Institution of Civil Engineers have made the following awards for papers read and discussed before the Institution during the past session: A George Stephenson medal and premium to Mr. R. A. Hadfield, a Telford medal and premium to Mr. J. T. Milton, Watt medals and premiums to Sir Albert J. Durston and Mr. H. J. Oram, a Crampton prize to Mr. Francis Fox, a Manby premium to Sir William Roberts-Austen, and Telford premiums to Mr. J. M. Dobson, Mr. W. G. Kirkaldy and Mr. A. P. Head. The presentation of these awards, together with those for papers which have not been subject to discussion and will be announced later, will take place at the inaugural meeting of next session.

PROFESSOR CARL CHRISTIANSEN, who holds the chair of physics in the University of Copenhagen, is at present visiting American universities.

THE following officers of the Royal Institution have been elected for the ensuing year: *President*, the Duke of Northumberland; *Treasurer*, Sir James Crichton-Browne; *Secretary*, Sir Frederick Bramwell; *Managers*, Sir Frederick Abel, Sir William Crookes, the Duke of Devonshire, Lord Salisbury, Lord Halsbury, Dr. W. C. Hood, Professor D. E. Hughes, Lord Kelvin, Mr. A. B. Kempe, Mr. H. Leonard, Sir Andrew Noble, Mr. A. Siemens, Mr. B. W. Smith, Mr. W. H. Spottiswoode and Sir Henry Thompson; *Visitors*, Mr. W. H. Bennet, Mr. A. Blyth, Mr. M. Horner, Mr. E. Kraftmeier, Lieutenant-Colonel L. W. Longstaff, Mr. F. McClean, Mr. H. F. Makins, Mr. L. Mears, Dr. R. Messel, Mr. L. M. Rate, Mr. J. C. Ross, Mr. W. J. Russell, Mr. A. G. Salamon, Sir James Vaughan and Mr. J. J. Vezey.

MR. ANDREW CARNEGIE has been elected an honorary member of the American Library Association in recognition of his munificent gifts for American libraries.

MR. CHARLES LEESON PRINCE died at Tunbridge Wells on April 22d. He became a member of the Royal College of Surgeons in

1843, but ceased the practice of his profession in 1874. He was a Fellow of the Royal Astronomical and Meteorological Societies and a member of the Scottish Meteorological Society, and the author of 'Observations on the Climate of Uckfield,' second edition, 1886; 'Observations upon the Great Comet and Transit of Venus,' 1882; 'On the Ancient Telescope of Hevelius, with Translation,' 1882; 'Observations upon the Climate of Crowborough Hill, Sussex,' second edition, 1898; and 'On the Rainfall at Uckfield for 50 years.'

Mr. Benjamin Vincent, who was connected for more than half a century with the Royal Institution of London, died on May 3d. The London *Times* states that he owed his appointment as Assistant Secretary in 1848 to Faraday, with whom he was connected by marriage. He became subsequently Keeper of the Library, retiring in 1889 with the title of Honorary Librarian. At the Royal Institution Faraday, who was about twenty years his senior, found in him an untiring and enthusiastic coadjutor in promoting the knowledge of scientific progress and the welfare of the Institution. Faraday was well aware of the importance of creating and maintaining public interest in scientific work, and in this respect was greatly helped by Mr. Vincent, who for many years, quite apart from the official duties of his position, drew up clear, condensed reports of the lectures and discourses delivered at the Institution, which were published in *The Times*, the *Athenæum* and the *Illustrated London News*. As Librarian he was responsible for the arrangement and selection of the large and valuable collection of books, and he found time to prepare an admirable classified catalogue of these.

The death is announced of M. M. Charles Brongniart, assistant in entomology at the Paris Museum of Natural History, at the age of 40 years. He was the son of the eminent botanist and had himself made important contributions to entomology.

Dr. Wilhelm Jordan, professor of geometry and geodesy at the Technical Institute at Hanover, died on April 17th, aged 57 years.

Professor Newton, of Cambridge University, announces that applications by students to occupy the University's table in the laboratory of the Marine Biological Association at Plymouth should be sent to him on or before June 1st.

The Division of Forestry of the Department of Agriculture is prepared to appoint a few well-qualified student assistants. They will be given practical field work, their expenses will be defrayed and they will be given $300 a year. These assistants should have preparation as follows:

(1.) Botany, emphasis to be laid chiefly on the structure and life of plants. Systematic botany need not be dwelt on at length. The knowledge essential to the determination of the species of trees is, naturally, of great importance. Cryptogamic botany should not be entirely neglected, although only a general view is required.

(2.) Geology, with special emphasis on the origin and meaning of the surface features of the earth.

(3.) Some physics and chemistry are essential, and a slight knowledge of zoology and entomology should not be omitted.

(4.) Mathematics should include geometry and trigonometry, and, preferably, mechanics also. A good working knowledge of surveying should be acquired.

(5.) Some knowledge of law and business methods.

(6.) German or French, preferably the former, and still better both together.

(7.) A good course in economics.

(8.) History and geography of the United States, with special reference to economic development and production.

Further information concerning these positions may be obtained from Mr. Gifford Pinchot, Chief of the Division of Forestry, Department of Agriculture.

By the will of Benjamin F. Horwitz, of Baltimore, $5,000 is bequeathed to Johns Hopkins University, the income to be used annually in bestowing a medal upon such member of the medical profession, either in this country or abroad, who has accomplished most during the preceding year in ameliorating the sufferings of mankind in the way of medical discoveries. This bequest is in honor of the memory of Dr. Eugene Horwitz, son of the testator.

We learn from the *British Medical Journal* that by a codicil to his will, dated February

20, 1899, Sir John Struthers bequeaths to the Royal College of Surgeons of Edinburgh the sum of £500 'for the purpose of promoting anatomical science' by founding a lecture to be delivered every third year before the College, the subject of the lecture to be on any part of normal vertebrate anatomy, the lecturer to be chosen at least a year before the lecture without restriction as to country or profession. Sir John Struthers left his large and valuable stock of anatomical drawings to the University of Edinburgh for the use of the professor of anatomy in the University. Most of the drawings were made by his own hand, and many of them direct from nature. Sir John Struthers also left to the University of Glasgow the sum of £500 for the founding of an award in anatomy for the purpose of encouraging original research or special practical work, the award to be made for original research or for the best special dissections or preparations or series of dissections or preparations relating to any part of anatomy, human or comparative, the decision to rest with the professor of anatomy in the University. The award is to be made every second year and to take the form of a gold medal with money prize. The prize is to be open to all students and graduates of the University of Glasgow, including the women students and graduates of Queen Margaret College.

THE annual subscriptions promised to The Liverpool School of Tropical Diseases now amount to about £2,500.

IN June next the Royal Institution, London, will complete 100 years of its existence, the first meeting of its members in the building in Albemarle street having been held on June 5, 1799. The managers have decided that this event, so interesting and memorable in the life of the Institution and in the history of science, shall be duly celebrated, and arranged for the delivery of two commemoration lectures. The first of these will be delivered on Tuesday, June 6th, by Lord Rayleigh, when the Prince of Wales, Vice Patron of the Institution, will preside and receive the honorary members; the second of the lectures will be delivered on Wednesday evening, June 7th, by Professor Dewar, when the Duke of Northumberland, President of the Institution, will preside. The Lord Mayor has consented to give a reception to the members and guests at the Mansion-house on the evening of Tuesday, June 6th.

PROFESSOR GUSTAVE GILSON, of Louvain University, Belgium, has begun, under the direction of the government of Belgium, a series of experiments in the North Sea. On April 29th a set of bottles was let off from the West Hindar light vessel, 2 degrees, 26 minutes east longitude, 51 degrees, 23 minutes north latitude—*i. e.*, about twenty miles northwest of Ostend. Each bottle contains a printed card, and it is hoped that any one who picks up one of these bottles will take out the card and fill up the blanks reserved for the place and date of finding, name and place if found on the shore, latitude and longitude if found on the sea, and send it to Professor Gilson.

DR. PETERS, the German explorer, arrived at Sena, on the Zambesi, on May 8th.

THE Duke of Abruces started from Rome on the 2d inst. for the polar regions. His purpose is to sail from Norway for Franz Josef Land in the steamship *Star of Italy*, go as far north as possible in the ship, and then to try to reach the pole with sledges. The king and the royal princes have, it is reported, subscribed $200,000 for the expedition, and the Duke will himself spend a large sum.

THE first statutory general meeting of the British National Association for the Prevention of Consumption and other Forms of Tuberculosis, of which the Prince of Wales is President, was held in London on May 4th. The Earl of Derby presided, and those present included Sir William Broadbent, Sir James Crichton-Browne, Sir Ernest Clarke, Sir John T. Brunner, M. P., Dr. Church, President of the Royal College of Physicians, Sir G. T. Brown, Mr. Edward Hulse, Professor McFadyean, Mr. C. Rube, Mr. Malcolm Morris, Treasurer, and Dr. St. Clair Thomson, Honorable Secretary of the Organizing Committee.

AT the annual dinner of the Sanitary Institute of Great Britain on May 2d the Duke of Cambridge, who presided, referred to the great work which it had done in promoting sanitary

knowledge. The public had made such use of the Parkes Museum, maintained by the Institute, that the Council had decided to start a building fund to provide a larger building to give the accommodation required for its increasing work. The Institute possessed 2,300 members and associates; its income last year was over £8,000, and its captital amounted to over £12,000. It had held 200 meetings, attended by 90,000 people.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. ANDREW CARNEGIE has given £50,000 to the proposed University of Birmingham, on the understanding that scientific work be especially emphasized in the University, instancing Cornell University as the best model to be followed. The committee, in thanking Mr. Carnegie for this gift, state that it had always been intended that special attention should be given to scientific training and research.

MR. PASSMORE EDWARDS has given £10,000 to the new London University for the teaching of economics and commercial science. The London *Journal of Education* states that the commissioners of the University have decided to establish departments of psychology, political science and engineering.

THE will of the late Professor Marsh, leaving his property to Yale University and the National Academy of Sciences, is being contested by a nephew. It is unfortunate that such contests should be so common in the United States. It is in any case fortunate that Professor Marsh during his life devoted the greater part of his fortune to scientific work and Yale University.

THE Georgia Federation of Women's Clubs have presented a scholarship to the Teachers' College, Columbia University, of the value of $450 a year. It will be assigned, on competitive examination, to an experienced teacher of the State of Georgia, and will be known as 'The Georgia Federation Scholarship.'

LAST year the University of Paris was given anonymously 75,000 fr. to permit five graduates to make a tour around the world. The gift has been repeated this year and increased so that each student will receive 16,500 fr. for the journey, which is expected to last two years.

NEW arrangements have been made for the award of the Bowdoin prizes of Harvard University. A prize of $300 will be offered to graduates who have been in residence within three years. The subjects are to be in the languages next year, in philosophy, political science and history the following year and in mathematics and science in 1902.

The *American Naturalist* states that The Gray Herbarium of Harvard University has recently purchased a collection of Compositæ of the late Dr. F. W. Klapp, of Hamburg. It contains about 11,000 specimens and will probably add 60 genera, 1500 species, to the Gray Herbarium, which previously contained 35,000 sheets of composites.

A COLLECTION from the medical library of the late Dr. William Pepper, formerly Provost of the University of Pennsylvania, has been presented to the University by his son.

A COURSE in commerce, diplomacy and international law has been established at the University of Pennsylvania. The course will extend over two years. The subjects proposed being as follows: *First year*—American diplomacy, American commercial relations, international trade and foreign exchange, political economy, economical resources of European countries, and public finance. *Second year*—international law, European commercial relations, diplomatic history of Europe, government of colonies and dependencies, practical economic problems, economic resources of the Far East, comparative constitutional law.

MISS LILLIE J. MARTIN has been appointed acting assistant professor of psychology in Stanford University, to replace Dr. Frank Angell during a year's leave of absence in Europe.

MISS EDITH CHICK has been appointed Quain student in botany for three years (£100 per annum) at University College, London.

THE professorship of pathology at St. Andrews, vacant by the removal of Professor Muir to Glasgow, will be filled on June 21st. Information regarding the appointment may be obtained from Mr. J. E. Williams, Secretary of the University.